

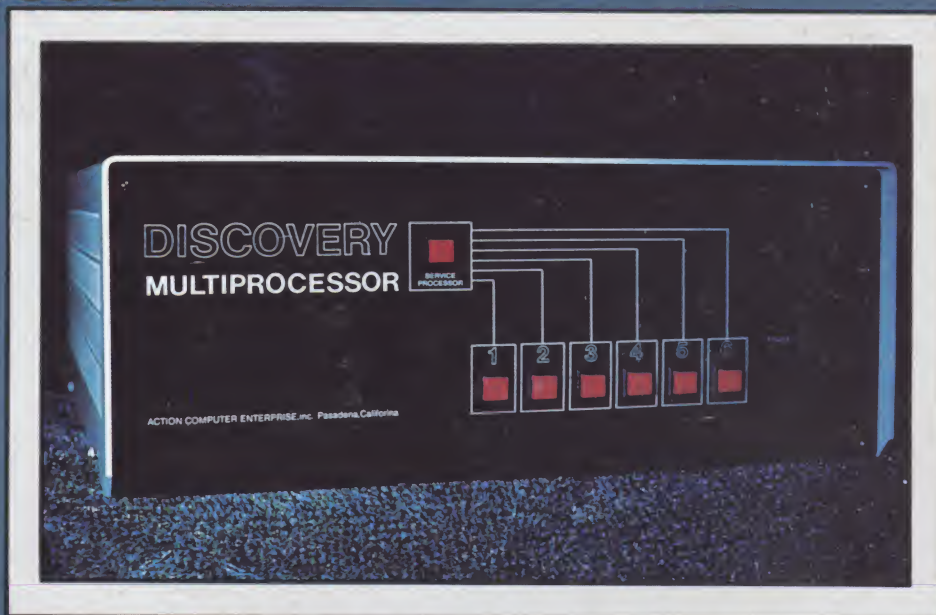
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T.M.

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Multiprocessor VS Multitask

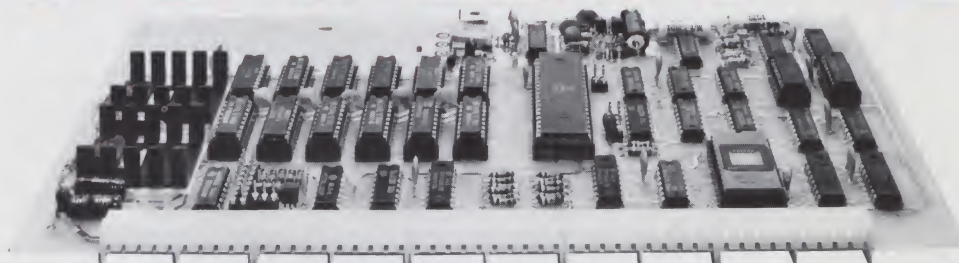
Systems
Square Off
In Business Arena



On Easy Street with the Apple II ☐ The S-50 Bus Strikes Back! ☐ Teach a Sorcerer New Tricks ☐ OSI Baud Mod ☐ Write a Happy Ending with PET ☐ North Star Quiz ☐ Struggle for Survival Simulation ☐ All About Data Structures ☐ Light-Fingered Computing ☐ Be a Better Writer with SWTP

Now! Color for Your...

SYSTEM-50



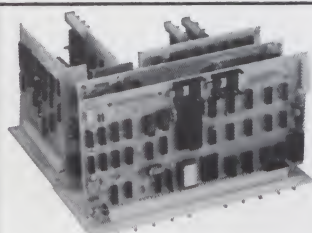
Introducing COLORAMA-50™ Percom's SS-50 Bus Color VDG

Introductory
Price

\$219.95

Featuring...

- **Eleven display formats** including 8-color semigraphics, 4-color graphics, 2-color high density graphics and 2-color alphanumerics.
Moreover, two- and four-color displays may be switched between primary and complementary color sets under software control or from the keyboard.
Full graphic resolutions range from 64 x 64 picture elements to 256 x 192 picture elements.
- **Instant display control:** The COLORAMA-50™ is memory mapped; your MPU has direct, instant access to display RAM and display control registers.
- **Low-cost Modulator Option for Color TV Interface:** The COLORAMA-50™ provides for installation of an inexpensive RF modulator such as Radio Shack PN 277-122 for operation using a color TV.



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- ✓ Color and monochrome memory-mapped display controllers
- ✓ Extendable 7-slot SS-50 bus motherboards
- ✓ Versatile prototyping boards: SS-50 and SS-30 bus
- ✓ Field-proven software: monitors, operating systems, drivers, editors, assemblers, debuggers and HLLs.

- **Mix in Sound:** With the optional modulator installed, you can complement your colorful displays with software-controlled audio.
- **Extended Addressing:** The COLORAMA-50™ is compatible with the SS-50A bus and the extended-address SS-50C bus. Map the board into any of the sixteen 64-Kbyte banks of the 1-Mbyte SS-50C address space. The COLORAMA-50™ card "defaults" to the first (lowest) bank for the SS-50A bus.
- **Cassette I/O Option:** Add a few inexpensive components to the on-card circuitry provided and use an audio cassette for program/data storage.
- **Provision for On-Card Firmware:** Put your display operating system, cassette control program, etc. right on the COLORAMA-50™ card in a 2516 (5-volt 2716) EPROM. Resides in the top 2-Kbyte of the card memory space.
- **Operating Software:** Included in the comprehensive users manual is a listing of a display operating system and cassette controller that may be implemented as a callable subroutine function from BASIC or existing operating systems. The programs are optionally available in a plug-in ROM for just \$69.95.

System Requirements

The COLORAMA-50™ is pin- and outline-compatible with the Percom System-50™ bus, the SS-50A (SS-50) bus and the SS-50C bus. The composite video-sync signal output will directly drive a color (or BW) video monitor. The output may be modulated for operation with a standard (NTSC) TV set. A modulator is not included. The COLORAMA-50™ card occupies 8-Kbytes of memory in the upper half of a 64-Kbyte memory space. Included on-card is 1-Kbyte of display RAM which will accommodate alphanumeric displays, semigraphic displays and two low-density full-graphic displays. For the higher density graphic displays, additional display RAM is required. The optional RAM ICs may be installed on the card.

For quality Percom SS-50 bus products, see your nearby authorized Percom dealer. To order direct, call toll-free, **1-800-527-1592**. Prices and specifications subject to change without notice. Prices do not include shipping and handling.

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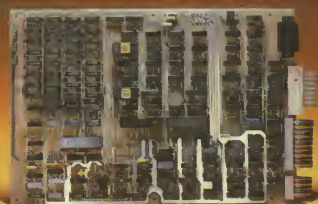
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You can retire in financial comfort.

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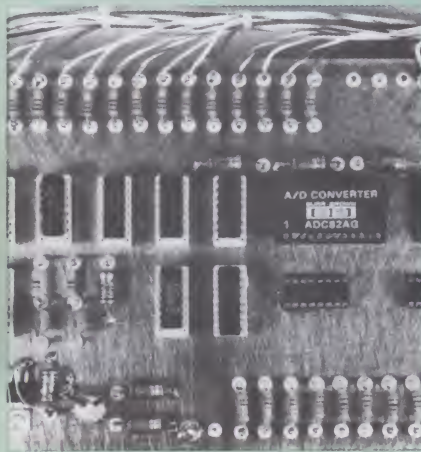
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This month:

As we sit here looking out at a cold, damp May morning, we find it hard to believe that the 1982 editorial calendar is already begging for attention.

But that's the way it is in the publishing business. The successive issues swirl dizzily across the screen of time like in a scene from *The Front Page*, each a memory before it even becomes a reality, each moving from the future to the past with only a brief pit stop in the present.

Our problem is compounded by the ever-changing face of the micro world. By the time we cover a new development, a dozen others pop up.

So the 1982 editorial calendar emerges, paradoxically, both full and unformed. Which of all the many topics do we choose to explore? Education, business, data communications, the home, medicine, science, social science, agriculture—which are most deserving of our attention?

At times like these, only one decisive course of action presents itself—throw the problem into the readers' laps. So here's your chance: What areas of the microworld do you want us to cover?

Please respond quickly. 1983 is just around the corner.

—The Editors

Next month:

The July issue will feature computer graphics—how to generate them on your system and how they can be used both in business and in the home. Also, the winning entries of our first annual graphics contest will be displayed.

The cover:

Multi-user systems: The Discovery Multiprocessor, top (courtesy of Action Computer Enterprises), and the System 40, bottom (courtesy of Integrated Business Computers).

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Ho-Hum Faire

Well-Attended, But Not Much To See

The Faire

Since most of you missed the sixth annual Computer Faire in San Francisco, let me briefly tell you about it. I did enjoy seeing a lot of friends, and a little bit of new equipment—precious little.

The regular air fare runs close to \$1000 for the round trip to the coast. Fortunately, there is a discount airline—U.S. Air—with a price in the \$300 range. It's a sort of red-eye special, arriving around midnight at Oakland. I got to bed by 2 AM (5 AM eastern time). Except for the arrival time, the airline is fine, with comfortable seats and the food about the same as most other airlines—not like that con-founded Aer Lingus line, which has seats so close together there is no room for your knees. I like to fly to Ireland (we have a plant there now), but it will be via London or Munich from now on.

Since there was a scheduled meeting with the Instant Software reps the day before the Faire, I arrived a day early and spent a good deal of the day talking with our rep organization. That evening Sherry and I managed tickets to Sweeny Todd, a Broadway show now resident in San Francisco. Ugh.

The Faire was a replay of the last one I attended. There were supposed to be 500 booths, and I'm sure there were. It took me two full days to get around to all of them even for a short visit. The exhibit halls (two of them) were either busy or packed much of the time. I kept asking everyone I met what they had found new at the show, and the answer was the same each time: the Osborne computer, and little else. The O-1 system drew crowds and elicited comments from many. Many people seemed anxious to get their hands on one. Others were critical of this or that design point.

Lee Felsenstein, one of the designers—if not the major designer—of the unit, was there answering the criticisms. Yes, he thought that the production models would have a larger screen. And, yes, they might be a little lighter in weight. I forget how many computers Lee has been involved with, but I remember see-

ing him a long, long time ago when he was putting the finishing touches on the Astral 2000 computer. It got a beautiful write-up in *Byte*, but I never saw one on the market. He then designed the SOL for Processor Tech. Maybe Lee will hit a winner one of these days—perhaps he has with the Osborne.

Few of the major firms in our business bothered to show at the Faire. For the most part there were smaller firms—and a lot of software. By my count, three of the top ten firms were there.

The attendees seemed to be almost entirely computer hobbyists, which is probably why the major firms didn't bother to spend the money. Some exhibitors said they were happy with the cash flow at the show, but most of the exhibitors were disappointed. The recession, at least in San Francisco, seems to have hit the micro field. By the time you add up the cost of air fares, hotels, car rentals, meals, booth space, booth exhibits and decorations, literature, shipping costs for the exhibits, people to man the exhibits and other expenses, it is unlikely that many exhibitors showed a profit. Mostly it seems to be an ego trip, which probably explains the preponderance of small firms.

Sherry and I collected literature from every booth we could. I've been looking this over and I can see why research shows that about 98 percent of the show literature is thrown out after a show and never read. Little of it is readable. I don't know what to do about that. There is an incredible need for some literature workshops to help manufacturers design and prepare their literature. Yet where can you run such a workshop? Exhibitors—the people who need to know this—are too busy during shows to attend a workshop. And where else are they together in one spot?

If anyone ever looks over literature from the viewpoint of the businessman who has no background in computers, he will find that virtually all show literature is wasted. Of course, much the same holds for ads in the magazines. I am planning a magazine for this readership for the fall, but where am I going to find ad-

vertisers whose literature the readers can understand?

While some of the booths at the Faire are getting more professional, a large number of them still feature card tables and signs written in Magic Marker. One of my fellow publishers, a holdout from the T-shirt and dungaree days of micros, runs one of the junkiest booths. If we ever do manage to set up a micro show which attracts businessmen in any numbers, we'd better learn to dress for success instead of the commune.

The PMC-80 seems to be progressing well, with their fast loader now a part of the system for really speedy cassette loading. They have been joined now by another TRS-80 software-compatible system, the LNW-80.

One surprise at the show was the absence of any Japanese entries. I suspect that they are still trying to figure out how to get into this market. This is a very big question for them. They know there is one hell of a market here, if they can get into it. Most of the people who know the answers are gainfully employed in the industry and not at all likely to whisper the secret, even if they know it. Perhaps we will see more at NCC.

Infoworld put on a cocktail party for the survivors of '76—the people who have managed to stay in the business for five years, which is a long time for this industry. I did spot most of the old-timers at the gathering. Some snacks were served, but there were so many people that the whole feeding part of the party was over in seconds. It seemed likely that more food would be brought, but it wasn't, so most people went hungry. John Craig got up to read a cute piece he'd written about the pioneers of the field, but he was unable to get the crowd quiet enough for many people to hear it.

The next evening I had dinner with Bill Godbout, George Morrow and Heath Kline (who runs those awful ads in another magazine). Both Godbout and Morrow make boards for people interested in the leading edge of micro technology—S-100 equipment. These chaps are so deeply into the industry that they know



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On my trip to the West Coast Computer Faire, I had dinner with (left to right) Heath Kline of Priority 1, Bill Godbout of Godbout Electronics and George Morrow of Morrow Designs. Note the small stereo recorder in the foreground. Copies of the entire dinner conversation can be had for \$500, and are a bargain at that price.

everyone and all of the scandals. It isn't often that I have dinner with people who have enough interesting things to say so that I shut up—I didn't get a word in edgewise.

The Faire? You didn't miss much.

Career Growth

The microcomputer field is growing at about 300 percent per year. Have you put yourself in a position to grow as fast (or faster) than the industry? It's all too easy to let the world go by while you sit still.

In terms of a career in microcomputing, this means that you want to look for some medium to smaller firms, ones that seem to have the best chance at keeping up with the growth. If you get boxed into a McGraw-Hill or an ITT, your chances of getting into any position of real authority are minimal. Big companies operate on the decisions of higher-level managers, who are most reluctant to accept either change or risk. It can be an extremely frustrating experience for a person with ideas, or for the entrepreneurial chap who wants to make things happen.

A lot of firms in the micro field have splendid prospects, and most of them are looking for people who are willing to work hard, have ideas and show a willingness to learn. I'm sure looking for that sort of people. In talking with the managers of other growing firms, I find that my needs are the same as theirs. A bright person, willing to make things happen, is most welcome.

In my firm, I need people to help sell ads for the magazines, and to staff the new *Desktop Computing* magazine I'm planning for the fall with editors, writers, circulation people and so on. Circulation sales are complicated, calling for skills in writing, direct mail and advertising, and in dealing with reps, newsstand distributors,

ing, evaluating, special programming, conversions for other systems, dealing with hardware firms, packing and shipping, evaluating the products of other software publishers, copyright protection, legal management, financial management, accounting, building maintenance, selling at shows, laboratory maintenance and repairs of hardware, point of purchase displays, automated material handling, materials purchasing and testing, quality control. . . it seems endless.

If you are interested in growth (and you don't smoke), we're certainly growing. Instant Software alone is expected to grow about 500 percent during the next year. *Desktop Computing* is aiming at a circulation of over 100,000 within the first year. Both *80* and *Microcomputing* are aiming at about 100 percent growth during this year. The book department is also looking at 500 percent or more growth.

Peterborough is a small town (4500) in a little isolated pocket which has so far avoided most of the incredible growth of the eastern part of the state (DEC, Wang, etc.). Most people live in the tiny surrounding villages, in a rural atmosphere, with Peterborough the shopping and business center. Housing prices are still very reasonable by California standards.

The quality of life in New Hampshire is without equal in our country—perhaps in the world. Taxes are minimal, the state is over 80 percent wooded, and the air is crystal pure. We're within easy driving distance of Boston for travelling and cultural events.

If you're interested in a career instead of just a job, write and tell me what you think you can do for my growing conglomerate, citing past experience to back yourself up. Money still talks, so be candid about salary requirements.

But, whether you are interested in the

stores, shows and clubs. Everything you do calls for a knowledge of the field plus careful measurement of results.

We need DP people to help set up new and more intricate data handling and communications systems. We need people to help Instant Software in the areas of marketing, advertising, promotions, packaging, duplication, master-

beauties of New Hampshire or the rigors of Silicon Valley, don't let yourself get into a spot where you are not able to grow with this incredible industry. Whether you are into the hardware, the software or any other aspect of micros, keep learning and developing your abilities and your career.

When you feel that you are being held back, look around. Be careful not to get sucked in by a big jump in salary to some position where you will no longer be able to have the freedom to learn and the right to make decisions. The lure of large companies has brought down many a good man. Yes, I tried it and discovered the frustrations involved. Fortunately, it was early on and I learned from the experience. That stood me in good stead when leaving college, when most of my compatriots were seduced by fantastic starting salaries, from big companies. Today they have little to show for their lives.

My publications have been the springboard for many careers, and, as painful as it may have been (in some cases) to lose them, I watched with pride as they moved on to bigger things.

Articles

A number of opportunities present themselves to those who prefer to work at home, including programming, program conversions and writing articles or books.

There is almost no limit to the need for informative articles. *Microcomputing* wants articles that will help the owners of all types of microcomputers on using different types of printers, on evaluations of programs, on networking systems, on uses in business, in education, in the home, for science, machine control, telecommunications, simulations . . . it's endless. *Microcomputing* is for the relative newcomer, so take it easy on the buzzwords. If you can only write for computer scientists, perhaps *Byte* is your medium.

My new magazine will need articles written for the businessman, totally without technical jargon. Businessmen already know that computers are going to help them and save them money, but they haven't the time it takes to become experts, so they need a magazine which will tell them, in English, what computers can do these days. We want articles written by the actual users, by dealers who have managed successful installations, by programmers with satisfied customers—or even by manufacturers with installations of which they are proud. Businessmen want information—straight information.

It isn't that hard to translate bytes into an equivalent of ability to store a certain number of names and addresses, or pages of text. Printer speeds can be expressed in how long it takes to type a one-page letter rather than characters per second,

lines per minute, etc. It will be an interesting experience for many writers to see if they still have some ability to write in English.

Authors should remember that we live in a publish or perish civilization. This means that when you go to look for a new position, every article you've had published is money in the bank. Many authors tell us that each article is equivalent to about \$1000 per year in added pay when they change jobs. Dealers will find that articles about them are a key to getting more customers. Consultants gain considerable credibility when they are published.

It is odd that so few firms in our field have managed to get articles written about their products. The consumers are desperate to know what really works—and they don't have to turn far to get an earful of horror stories.

One more thing. We pay right up front for all articles, upon acceptance.

Classes in Shambles

Recent studies reveal the sad plight of teachers in today's educational systems. Classes are in a shambles. It is becoming almost impossible to teach because an ever-increasing number of students have lost interest and are distracted by those youngsters who are there against their will. It is no wonder, then, that teachers are deserting the field by the tens of thousands.

When I see movies of teachers trying to cope with children who are uninterested in learning, I wonder why these teachers aren't pushing as hard as they can for computers to take over their thankless jobs. With individual computers for each student there would be less opportunity for students to create havoc, throw erasers (there will be no more erasers) or molest the teachers.

Through computerized teaching systems we will eventually be able to provide a better quality of education than is currently available in most schools. Courses can be made interesting and be taught by some of the best teachers in the world. The computer, as I've written before, may be used to adjust the speed of the teaching to the interest and intellect of the student, rather than just for drills of data to be committed to memory.

Once we have been able to develop better teaching systems, not dependent upon teachers for other than some minor support and advice, it may be possible to move these systems into the home—much as we expect work stations to be able to move into the home once we have adequate communications systems to support that mode. This may be a healthy change for society and, in the long run, result in better-motivated children.

There are many factors which have brought about the changes in schools

over the last 40 years. We can certainly point fingers at the almost standard two-parent working family which is now needed just to pay for homes and food, but has reduced the influence of the mother in the home during after-school hours. Worse, the ubiquitous TV not only claims our children, but almost totally occupies the parents in the evening too, removing the chances for any serious communication between parents and children—other than sharp demands to temporarily solve problems.

Then we also have that steady diet of violence on television. There is no way that can be helpful. Add to that the doctrine of Dr. Spock and the "let the children do what they want" attitude, and we may have the roots of the lack of respect, the graffiti, the vandalism which is now engulfing us.

One of the problems of compulsory education is that it not only forces kids to be in school when they are uninterested—and are thus prone to interfere with those who are—but it also acts upon the teachers, who have captive audiences and thus no responsibility to make the work interesting.

If education is to succeed it is going to have to realize that it is show biz and accept that it is going to have to be interesting. It really can be done.

What about kids who are *not* interested in education? Isn't it enough that we make it available? Taking the horse to water, as it were, but agreeing that we don't have to make it drink?

We're prisoners of our past in much of this. Schools developed for some good reasons. They evolved into giant baby-sitting systems for most families, keeping kids out from underfoot—and out of the streets, at least for most of the day. Summer vacations may have been a blessing for the kids, but many mothers sighed when they came.

Perhaps we should legitimize child labor, get rid of the minimum wage requirements for children under 18 and see what happens. Oh my bleeding heart! Would kids find that the alternatives to school are less pleasant than school?

One of the problems, obviously, is the concentration of the poor which has built up in most of our cities. These people came into town from the farms a generation or two ago and have been dragging our whole society down. The answer to most of their problems is education and motivation, but no one knows how to get those started for this group. The problem is killing the cities as well as poisoning our country, so some solution must be found.

I don't know whether or not automated education will help those who need education the most. Can some means of motivation be found? Well, we *have* to do something. In the meanwhile, automated education should help make information and understanding of our world

available to those who do have the motivation and who let themselves be helped by this resource. It will enable them not to be dragged down by those who are unmotivated and who are trying to prevent others from learning.

It is my intention with Instant Software to pursue the development of automated learning systems. I have in mind, at present, something akin to a video cassette which is coupled to a microcomputer. The micro would be programmed to show the video program and stop every now and then to make sure the student is keeping up with the material. If the student is unable to answer questions correctly, the machine would rewind and go over the material again, ending up with a different series of questions. In this way the progress of the course would be matched to the student.

If this should catch on, I can see a time when we might be using video disks. Even if a particular program were to cost several million dollars to produce, it would be a bargain because we could use it to teach hundreds of millions of people. It could be translated into any language and provide a relatively low-cost education, even for the most remote and poorest of the third-world nations. □

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ROM Packages From Skyles

Command Repertoire Expanded

Here's some information on two interesting ROMs from Skyles Electric Works:

Command-O

Command-O is a 4K ROM for the 8016/8032 computers that adds 19 commands to BASIC. Eight of these commands are for program editing and debugging. The remaining commands provide powerful BASIC commands for screen formatting and disk file manipulation. Most of the commands can be used in direct or indirect statements. Here's a quick description of the commands provided:

INITIALIZE sends the initialization command to the disk to initialize one or both diskettes. The initialize command is not supported by BASIC 4.0 and would normally have to be sent via the command channel (channel 15). This command eliminates the need to use the command channel, and thus does not waste disk buffer space.

MERGE loads a program from disk and places it at the end of the current program in memory. If a specific line number is indicated in the MERGE command, the program is stored starting at that line number instead of at the end of the program. This lets you use program overlay techniques easily. Valid line numbering is the user's responsibility, since the merge command does not make any check on the line numbers in either program.

MOVE moves the cursor to a specific row and column position on the screen.

EXECUTE loads and then runs a program from disk.

SCROLL turns on the paging window, the enhanced screen editor and the softkey features (described later).

OUT disables the features enabled by the SCROLL command.

SET predefines a specific keystroke sequence of up to 190 keystrokes for any one specific key on the keyboard. This

softkey feature is similar to Program Function (PF) keys on larger computer systems. It allows redefining any key as a common or heavily used command sequence. This can be a great time-saver and a real convenience once you get accustomed to using it.

KILL disables the ROM software and all related functions.

SEND sends a command directly to the disk without opening the command channel and tying up disk buffer space. This can actually be used to send an IEEE command to any IEEE device.

PRINT USING is not a full function PRINT USING but is still very powerful and extremely useful in the form provided. A string variable defines the print format using number signs (#) to define character positions (or fields) within an 80-character line. Numeric data can be formatted with separating commas and a fixed decimal point, with up to ten digits maximum. It does not support floating dollar signs, leading zeros and additional functions commonly provided by PRINT USING commands on other systems. Also, you cannot have fixed text within the format specification. Only #s are allowed to define the fields that are to be substituted.

BEEP provides an easy method of generating sounds using the CB2 line of the user port. The command allows setting the duration and tone of the desired sound.

AUTO provides automatic line numbering when entering BASIC program lines. It allows specifying the starting line number and the step value to be used between lines.

DUMP displays a list of all nonarray variables. It will indicate all simple string, real and integer variables.

DELETE allows deleting a range of program lines that are expressed just like when using the LIST statement.

FIND locates and displays a BASIC pro-

gram line containing a specified string or statement. Optionally, a specific line range can be examined instead of searching the entire program.

HELP requests help about an erroneous line. The line in error will be displayed with a reverse field marker where the error most likely occurred.

TRACE enables the tracing function for tracing and single stepping through BASIC program lines. When enabled, the current line being executed is displayed at the top of the screen.

OFF disables the tracing function.

RENUMBER provides a handy line-re-numbering utility. You can specify the starting line number, the increment value and even a line range to be renumbered if desired.

The enhanced screen editor provided by Command-O lets you scroll up and down through a program listing by using the cursor-up and cursor-down keys. You don't have to continuously LIST segments of the program that will fit on the screen. Just list any part of the program, then scroll to another desired section if not currently on the screen. Another feature of the new editor is repeating keys. Any key held for more than a half-second will repeat at the rate of 15 characters per second until the key is released. This occurs for all keys on the keyboard, including all cursor movement keys.

The 8016/8032's new control characters are now generated at the touch of a key with Command-O activated. The Command-O editor transforms the "ESC" key into a control key. Any key pressed (A-Z) while the ESC key is held generates the appropriate ASCII control key value. Thus, if you hold ESC and press G, it generates a control-G code and

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sounds the bell. The new control characters supported are:

- scroll up or down
- insert or delete entire lines
- delete characters to the left/right of cursor
- select Text or Graphics mode
- ring the bell
- define the screen window

Another nice feature of the enhanced screen editor is the ability to "eat" characters to the right of the cursor. When the stop key is pressed the cursor stays in the same position and the character to the right of the cursor is deleted. The remainder of the characters on the line are drawn to the cursor to replace the deleted character.

The addition of the Command-O ROM does add many useful and powerful commands to the standard 8016/8032 system. Keep in mind, though, that whenever activated, there can be a significant increase in execution times when running BASIC programs. Also, programs written with the new commands will not be portable to other systems unless they also have the Command-O ROM installed. However, the debug and editing features are extremely handy. Also, remember that you can enable and disable the ROM at will, with complete control of when the features are active.

Disk-O-Pro

The Disk-O-Pro ROM is for older PET/CBM systems that haven't been upgraded to the BASIC 4.0 ROMs. Disk-O-Pro adds all the BASIC 4.0 disk commands plus some new ones, and gives you access to the Programmer's Toolkit as well (if you own one).

The ROM normally mounts in the empty UD3 socket that is addressed starting at \$9000 hex. There's even special mounting hardware for all known PET

models and various expansion hardware configurations. Even though Disk-O-Pro will function with all versions of the Commodore disk (2040-DOS 1.0; 4040-DOS 2.1; or 8050), the 2040 disk with DOS 1.0 cannot support all Disk-O-Pro commands.

Table 1 shows the Disk-O-Pro commands that are in addition to those provided by the Programmer's Toolkit if available.

The BASIC 4.0 disk commands function as described in the Commodore documentation, use the same command syntax and generate the same token values within programs. The remaining commands are the same as the corresponding functions provided in the Command-O ROM and described previously.

The documentation provided with the Disk-O-Pro ROM is an excellent 84-page manual written by Gregory Yob. It provides plenty of examples, information on the internal workings of the commands, hints on using hidden features and cautions or warnings where appropriate.

All Disk-O-Pro commands can be executed as direct or indirect statements, but, as mentioned in the manual, several precautions must be observed. The ROM must be enabled to correctly handle any program using the added commands. Disk-O-Pro converts the new commands to special token values that are normally unused by BASIC 3.0. The ROM must be enabled to properly decode these token values for any function: editing, listing, executing, etc.

Previously, many of the ROM-based software additions were used primarily during program development, but were not needed after the program was completed. Disk-O-Pro, on the other hand, actually participates in running a program. This means the program will run slower and the same program may not be able to run in a system which does not have Disk-O-Pro installed.

KILL	HEADER	RENAME
BEEP	CATALOG	SCRATCH
SCROLL	DIRECTORY	MERGE
OUT	BACKUP	CONCAT
SET	COPY	DOPEN
PRINT USING	COLLECT	DCLOSE
INITIALIZE	DSAVE	APPEND
SEND	DLOAD	RECORD
EXECUTE		

Table 1.

On the other hand, compatibility with the new BASIC 4.0 is quite good. Disk-O-Pro uses the same token values and follows many of the internal 4.0 procedures. There's a good chance that a program using these features would be portable between systems. You should be aware, though, that there are a few minor differences that could possibly cause problems. The special variables DS and DSS are provided and make error checking on the disk a very simple task. BASIC 4.0 checks the disk status only when the status variables are referenced. However, Disk-O-Pro checks the disk status with every normal disk activity and stores the disk status as ordinary variables. Thus, the DS and DSS values will be lost after a program change, a CLR or a LOAD.

Another area I should point out is that there are a few things provided by BASIC 4.0 that Disk-O-Pro can't handle. The changes to BASIC are too fundamental for an add-on package to emulate. The garbage collection delay is still there with Disk-O-Pro. Also, the problem with line feeds after a carriage return in a PRINT# statement still exists. With Disk-O-Pro you'll still have to use the familiar PRINT# . . . ;CHR\$(13); statement when writing to disk. There are a few other minor differences concerning the IEEE bus, but these shouldn't matter to most users.

Remember that Disk-O-Pro does offer several features above those provided by BASIC 4.0 but that these cannot be used by another system unless the Disk-O-Pro ROM is installed. Also, with the Disk-O-Pro ROM you don't lose the capability of using the Programmer's Toolkit. If you upgrade to BASIC 4.0 you'll not be able to use the Toolkit with the new system ROMs. All in all, the package is very nice and has its good and bad points. Its value to you depends on your needs and system configuration. Also, remember that you do have control over whether or not the ROM software features are active.

For more information on either ROM package, Command-O or Disk-O-Pro, you can write: Skyles Electric Works, 231E South Whisman Road, Mountain View, CA 94041.



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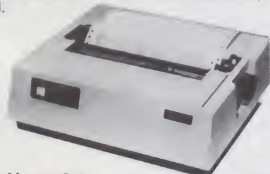
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vices recently announced a small but interesting collection of educational programs for the PET. The programs were developed by educational psychologists and extensively tested in classrooms.

A Match Game is useful for memory building, and for putting lesson reviews into a game format. The game can be played with either exact matches or paired matches. Users can choose from the many options built into the program (shapes, math and synonyms) or enter their own items. The size of the game board can be varied and one to four players can participate.

The Letters & Numbers program is ideal for young children first learning to use the computer. It uses upper- and lowercase letters and numbers created with the PET graphics. Options within this program include matching of one or more items, completing sequences and filling in missing items. In each option, letters, numbers or both can be selected.

The Addition and Subtraction programs are suitable for grades one through six and for special education classes. Problems are presented vertically and answers are input from right to left just as you would think through the problem. For added convenience, carrying or regrouping (borrowing) can be marked in the problem. Immediate feedback is given, with graphics reinforcing correct responses. By making selections from a menu, the user can select the number and level of difficulty of the problems, set a time limit or the number of attempts allowed on each problem, and control several other aspects of the program. The addition program has 24 levels of difficulty while the subtraction program has 12 levels.

The sample copies of the Addition and Subtraction programs received for review were excellent. In fact, the Addition program was awarded second prize in the Texas Instruments Author Incentive Program. The programs were completely user-proof. Pressing inappropriate keys does not affect the program, except for displaying a "STOP IT" message. Also, the PET stop key is disabled to protect the program.

The problem displays are wide-spaced for easy reading. The number zero (0) is replaced with the letter "O," since it was found that some children found zero (0) and eight (8) hard to distinguish on the PET. The problems themselves are done in the way children are taught to do them; the child does not have to adapt to the computer. In addition, the child receives immediate feedback. Correct answers are reinforced by cute robot figures using graphics, and the child's name is included in messages part of the time.

The teacher can preset the number of tries the child is given for each problem. When multiple tries are allowed, an incorrect answer is moved to the bottom of the screen with a "TRY AGAIN" message displayed. The most recent incorrect an-

swer remains on the screen, lined up with the problem so the old and new answers can be easily compared. Special messages are used if the child is slow in responding or makes too many inappropriate responses.

The programs are especially suited for classroom use with special controls built in for teachers. For example, a teacher can set the level of the problems and a time limit. Each child can then work on the computer for the set amount of time without the teacher. The program cannot be stopped except by pressing Shift-@ at certain times. After each set of problems, various statistics are displayed to indicate:

- number of problems right on the first try and the average time per problem.
- number of problems right after the first try.
- number of problems wrong.
- total time for all problems.

I must say these are excellent pieces of software. Each program is supplied on cassette tape for \$20 and versions are available for all model PET/CBMs. For more information, you can write Teaching Tools: Microcomputer Services, PO Box 12679, Research Triangle Park, NC 27709. In Canada you can contact SES (Computing) Inc., 267 Bain Ave., Toronto, Ontario M4K 1G2.

Book Review

I just finished reading a copy of the second edition of the *PET/CBM Personal Computer Guide* from Osborne/McGraw Hill. This is a 500-page book and lists for \$15 in paperback form. The new edition now covers all model PET/CBMs, including the new 8000 series, BASIC 4.0 and DOS 2.0. It discusses the various model computers, the cassette drive, the 2040 and 8050 disks, and the 2022/2023 printers. The new edition covers just about every possible area of the Commodore system at the time the book was published.

This edition is a major revision of the original book published under the same title. The discussion of BASIC programming has been greatly expanded, and there are many sample programs and examples throughout the book. It covers everything from how to run programs already written to learning BASIC programming and programming techniques required for peripheral units.

The book is roughly divided into eight chapters, along with a number of appendices. Chapter 1 gives a basic introduction to the CBM computer. It shows what the CBM looks like, points out the differences between models and shows the various Commodore peripherals. The second chapter discusses how to operate the computer while the third chapter explains the screen editing features. The next two chapters discuss BASIC programming in simple terms and how to

make the most of the CBM features.

Chapter 6 covers the peripheral devices in great detail, including the tape, disk and printers. It covers all the features of each device with many examples on how to use each. The seventh chapter provides miscellaneous information for the more advanced user. It discusses how and where variables are stored, memory maps, assembly language programming, random access disk files, etc. The last chapter gives a detailed description of every BASIC statement and function, including the new 8000 series special functions.

Hidden in the appendices is a wealth of information, including detailed character code charts, notes on variations for the older Version 2 BASIC and detailed memory maps (both RAM & ROM).

Of special interest is Table F-3, which shows a list of all source code labels within the CBM BASIC ROMs for both BASIC 3.0 and BASIC 4.0. This one table can give you some indication where the various major routines are located in the BASIC ROMs, along with a cross-reference of the corresponding locations in both BASIC versions.

This book is definitely of interest and great value, regardless of your level of expertise. I should warn, however, that the latest edition has a large number of typographical errors. A second printing of this edition is supposed to fix these problems. There are also a few areas that are totally wrong and do not apply to the PET/CBM systems. The biggest problem areas concern the programming of disk files. Since the book was updated for BASIC 4.0 and DOS 2.0, the areas discussing BASIC 3.0 have a number of errors and should be used with caution.

Also, the book discusses a few items like program overlays and program line-formatting that do not apply to the PET at all. This type of logical error is planned to be fixed in a third edition scheduled for later this year. The next edition may also include more information, such as details on the machine-language monitor.

Even so, the current edition is still a great value and contains a good deal of information.

Miscellaneous

The publishers of *Compute* have announced a new magazine especially for the Commodore VIC computer. Under the name *Home and Educational Computing*, the quarterly magazine was scheduled to start with the April-June issue, so it should be available by now. The material is intended to teach, entice and interact with readers to help everyone develop maximum benefit from the new VIC personal computer series. A special introductory price of \$5 is available for the first three issues. For more informa-

tion, write: Home and Educational Computing, PO Box 5406, Greensboro, NC 27403.

I finally got my 8050 disk from Commodore, so now I can review any programs that require the new high-density disk. If you have an older 2040 disk and have upgraded to DOS 2.1, you might want to try and get a copy of the new disk manual from Commodore. They now have a single user's manual for all 5-1/4-inch disks. The new manual covers the 2040, 3040, 4040 and 8050 disks and can be ordered as part number 320899. Unfortunately, I haven't been able to find the price.

The new disk manual includes descriptions of the programs supplied on the demo disks and the new disk commands in BASIC 4.0, along with handy quick-reference charts. Of special interest are the detailed descriptions of the disk header, BAM and directory formats for each disk type. This is definitely a very handy and valuable reference for any disk user.

For those who haven't seen the new nomenclature, 2040 is the original disk with DOS 1.0, 3040 is the European version and 4040 is the 2040 disk with the newer DOS 2.1 ROMs. By the way, now that I have an 8050 disk, I've created a new version of my DISK MASTER disk cataloging program for the 8050 drive. Contact me if you need more information.

LemData Products has announced a newer version of its PIE printer interface. Their original interface module was only designed to interface printers that used the standard Centronics interface. The PIE-C will interface just about any eight-bit parallel interface device to the PET IEEE bus interface. The new interface module mounts directly to the CBM with a custom enclosure.

The PIE-C provides complete address selection for device numbers 4 through 30. It works with WordPro and other programs that output true ASCII. There is also a CBM-to-ASCII code converter built in so you can print from BASIC or output program listings. All 256 codes are provided in either mode so you can use the printer control codes. Cost of the new module is \$119.95 plus \$5 shipping. For more information, write LemData Products, PO Box 1080, Columbia, MD 21044.

In case you haven't heard, Commodore has a new 4022 tractor feed printer available. Based on the popular Epson MX80 dot matrix printer, the 4022 offers the full CBM graphics set, reverse characters and many programmable features. Details and pricing were still sketchy at this writing, but this should be a very nice addition to the Commodore line.

Several people have reported various problems with the regular Epson MX80 printer's handling of upper/lowercase with the CBM. So far I haven't been able to find any more information on this but I'm still working on it. If you have any information that may be of help to others, please write. □



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Revolution On the Wane?

Operator Enthusiasm Fizzling

The data communications revolution is rolling on, but have we reached a peak in the number of available bulletin board message systems? This month, I will discuss the rise and probable fall of microcomputer-based electronic message systems. I'll also look at what I think is the top terminal program for the TRS-80: Omniterm.

The Peak?

I recently contributed some background material for an article on electronic message systems (CBBS, ABBS, Forum 80, etc.) in the *Wall Street Journal*. I was happy to see the interest shown by this international publication in the commercial applications of what have been hobby systems. In the course of describing message systems to the *Journal* staff, it occurred to me that this phenomenon might not go on forever. This might seem like a strange thing to say when new systems are still appearing regularly, but the rate of growth has certainly decreased.

Please don't misunderstand—there has been no decline in the number of users of message systems or in the number of people interested in data communications. Modem makers and software sellers are still awash in orders, but the microcomputer-based message system rage is maturing.

It takes a considerable investment of time and money to run a message system. The average system operator is tied to his machine about half an hour a day simply viewing the screen for appropriate messages, backing up disks and compacting files. The disk drives get heavy use and maintenance can become a real concern. Several thousand dollars' worth of equipment may be dedicated to message system operation with no offsetting income or depreciation.

The thrill of being at the center of activity or the fulfillment of providing a service can wear thin quickly. Many systems come "on the air" with great fanfare, only to disappear with a gurgle and a sigh a few months later. The first wave of

exuberant enthusiasts has broken on the beach and subsided.

The surviving system operators will be those with more practical or deeply-rooted reasons for running a system. They will also probably have some support in their work. Special-interest systems will continue to grow in some areas—although several of these with seemingly good potential have died already.

Systems sponsored by clubs in large metropolitan areas will do well. Systems sponsored by manufacturers (North Star, Microperipheral Corp., PMMI, etc.) should continue to be strong because of the service and communications with customers they provide. But otherwise, I predict the gradual demise of the simple message system run by an individual.

The increase of special-interest message systems on the information utilities (CompuServe and The Source) has created a form of competition for the privately-owned bulletin boards. The use of a tiny fraction of the information utility's processing power for a multi-user message system is more practical than the dedication of a microcomputer in many applications. The utilities can provide program transfer, large storage capabilities and other features found only on the most sophisticated bulletin board systems. The cost of the information utility is probably not as much of a limiting factor to growth as the lack of local circuits in many parts of the country.

Interestingly, there seems to be growing commercial use of microcomputer-based message systems for certain dedicated uses. Corporations can make use of sophisticated bulletin board systems to support research and development teams. Traveling marketing people can check into corporate systems at any time of day or night to pick up the next day's calls, deliver orders and run programs to figure commissions or discounts. Software maintenance and development personnel can exchange notes or even lines of code.

These people can appreciate and afford microcomputer-based systems because

they avoid the problems of writing special software for large mainframe computers and the hassle of large system software documentation.

I can predict some parallel but separate trends. Strong centralized and well-supported systems will emerge. Software sophistication will continue to increase. Privacy and security needs will grow too. Corporate users may use more small systems, and private users may use more big ones. The microcomputer-based data communications era will emerge from the shake-out stronger and more useful than ever.

Omniterm

Last month, I mentioned a fine TRS-80 data communications program called Omniterm, written by David Lindbergh. It is available from Lindbergh Systems, 49 Beechmont St., Worcester, MA 01609.

Omniterm lets you use your TRS-80 as a smart data-communications terminal. It is a powerful program with many features. It takes a little experience to get the full benefit of all of the program's sophisticated options, but even a novice user can get on-line using the software in a matter of minutes. Let's look at the features that make the program so versatile.

Like other smart terminal programs we have reviewed, Omniterm will save the data received from an electronic message system or information utility on disk files. It will also allow the preparation of messages off-line for later retrieval from disk and efficient transmission out the serial port. It will provide a buffered output which sends all received data to a printer connected to the parallel port. The program will allow transmission of control codes and special characters such as brackets.

In common with the best terminal programs, Omniterm provides for the one-key transmission of a prestored block of data called a macro. This macro string is useful for the transmission of log-on codes, passwords and other frequently-used lines of letters and numbers. The macro characters are saved on disk and



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loaded in with the program at start-up along with other system operating parameters. These tables of system parameters lead to one aspect of Omniterm which makes it unique in the area of TRS-80 terminal programs—flexibility.

One of the major jobs of any terminal program is translation. Characters flying between the keyboard, serial port, parallel port and video display all must be encoded and decoded by the software. Most terminal programs provide their own unique keyboard decoding tables—that's how they can provide special characters and control codes—but they usually have only one or two tables which translate all codes.

Omniterm provides seven translation tables which handle characters going to and from the serial port, to and from the disk operating system, to the printer, to the screen and from the keyboard. These tables can change all characters, not just special characters and control codes. This means that Omniterm can speak in different data alphabets such as EBCDIC (but not Murray/Baudot; it can't handle the shift code). It also means that it has a nearly infinite ability to translate special control codes that might mean one thing to a video screen and quite another to a printer.

Some control codes meant for screen

formatting can make your printer do strange things if they hit it in untranslated form. Many people have EBCDIC printers which they would like to use. The separate translation tables will allow the entire system to run in ASCII except for the printer driver which can be EBCDIC.

Omniterm provides the user with the ability to build a terminal program customized for both the local hardware and the remote system. This customizing can be changed for a new remote system or hardware configuration simply by loading in a different settings file from disk. A microcomputer can be changed from a terminal for an EBCDIC-speaking large mainframe to a terminal for an ASCII-speaking ABBS simply by loading in a different data file containing the alphabet tables, transmission characteristics, screen format parameters and macro listing. This system of translation tables and specification files gives great flexibility and customizing potential.

Another special feature of Omniterm provides great flexibility in the use of the buffer storage area. Buffer storage is simply RAM space that holds received data or data loaded in from disk files. In other programs, the buffer can be read only off-line or after the data in the buffer is stored on disk. Omniterm allows the user to look back in the buffer—even on-line—to read again what has already scrolled off the screen. This is a significant convenience for users of electronic mail and bulletin board systems. It gives an instant replay capability just as valuable as the one on televised football games.

One very real disadvantage of the electronic mail systems available to most us-

ers is the lack of any original note to work from when writing a reply. You usually have to rely on your own memory or hand-scribbled lines to recall the things the other person said.

Some very sophisticated terminals and a few microcomputer terminal programs can provide a protected screen area which freezes and holds received data. These can be used effectively with a little practice. Omniterm's scrolling buffer provides an easy way to help the user remember what has passed off the screen.

The screen of a terminal system using Omniterm has a unique look. The program "knows" how wide the terminal screen is and breaks lines that are too long at some point between words. Many programs have this wrap-around feature. These other programs usually deposit the leftover word(s) on separate fragmented lines. They then recognize the carriage return at the end of the fragmented line and begin a new line. This gives the screen a very choppy appearance and makes narrative material hard to read.

Omniterm will change carriage returns to a space if a line is too short and add its own carriage return when a line is too long. This feature eliminates fragmented lines and the short lines sent by many systems. An Omniterm screen is clean, full and well-balanced.

The Omniterm manual is also full and well-balanced. It has over 60 pages and even includes a glossary and complete index. A good manual is a must with a program this sophisticated, and David Lindbergh has done well.

Omniterm has many features which I

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The Radio Shack Modem I is a direct connection modem providing originate and answer operation. It can be used as a standard RS-232-C connected modem, or with a special cable and software, it can operate with the TRS-80 Model I keyboard in the half-duplex mode. It sells for about \$150.

don't have room to describe, but they include a large graphic picture of a bell that appears on the screen when a control G is received, a timer to tell you how long you have been on-line and complete command menus at every program level.

The program will run on a TRS-80 Model I with 32K of RAM and one disk. A version for the Model III should be available by the time this is published. Omniterm has my vote as the top TRS-80 terminal program available today.

Mailbag

Three quick items out of the mailbag this month: You have probably seen the new Radio Shack modem for the TRS-80. It was first described in a February flier. (Cat No. 261172, \$149.95.) What they didn't say in the flier is that the device can be operated directly from a Model I keyboard without an expansion interface—but only in the half-duplex mode. You can address most bulletin boards or information utilities in half-duplex if you instruct them properly. (The D command on a CBBS or ABBS toggles between full- and half-duplex.) Half-duplex will not provide the constant check of operating conditions gained from full-duplex operation, but the price is hard to beat.


AMRAD, the Amateur Radio Research and Development Corporation, has published a good bulletin board list. Terry Fox and others in the club have put a lot of work into making the list as accurate as possible on the day it was printed. Drop \$1 to AMRAD, 1524 Springvale Ave., McLean, VA 22101.

There is a big push on in California to force the telephone companies to provide TTY devices for deaf communications. These devices use Murray/Baudot code and cannot normally communicate with ASCII systems. Novation, Inc., has announced the development of a \$650 portable combination terminal/telephone called infone. It has a store-and-forward-message capability, can use either Murray or ASCII and can actually "talk" in synthesized speech with a 250-word vocabulary for the visually handicapped. I will get more information on this development for next month's column, but look out—the future just tapped you on the shoulder.

Keep It Coming

If you operate a message system or market a data communications product, I would like to hear from you. Questions and comments are always welcome, but please include a stamped envelope if you expect an answer to paper mail. Send electronic mail to TCB967 on The Source, 70003,455 on CompuServe, or via the AMRAD CBBS 703-734-1387. □

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Multiple Precision With Micros

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More Multiple Precision Arithmetic

Last month we discussed multiple precision division and began to address the question of multiple precision multiplication. Listing 1 contains the program we developed to multiply an N-digit integer by a single-digit integer. To use this program, enter the numbers to be multiplied as data in lines 10 through 30. Line 10 contains the number of digits contained in line 20. Line 30 contains the single-digit number that multiplies the N-digit number of line 20.

The ability to adapt the algorithms of one program as part of another program is a valuable skill that all should develop. Last month's illustration of 3^{1690} was produced by a program written by a twelve-year-old who had discussed the program of Listing 1 as part of his class work in school. He extended the idea only slightly so he could produce tables of an integer raised to sequential powers. The program in Listing 2 will print the expanded form of $3^1, 3^2, 3^3, \dots$ and on and on until the expanded form exceeds the number of digits indicated in the DIM statement of line 20. The limit of 3^{1690} imposed in line 40 is arbitrary.

Notice that the working portion of the program in Listing 1 (lines 100-160, 180) is identical to the working portion of the program in Listing 2 (lines 50-120). This student very nicely applied an algorithm learned in one situation to help him in another similar situation. He wisely made use of integer variables for all his computations, since this is a near-perfect example of a program in which the speed of integer arithmetic is an important asset.

The variables used are: N—the number of digits in the product; D(I)—the i^{th} digit of the product, counting from the right; M—the base; and K—the value of the exponent. All other variables are identical to those used in the program of Listing 1. Notice that the program can compute the powers of any single-digit number by changing the value of M in line 30 and the

digit printed in line 150.

Even if students are too young to understand the concepts of this program, they are quite likely to be interested in the program's output. Obtain access to a printer, then calculate and print 2^1 through 2^{1000} , then 5^1 through 5^{1000} , then give the output to students and enjoy the results. You'll find students pursuing many different tangents from this inspiration, most of which will be clearly productive.

One rather predictable outcome of these programs is the desire to obtain the multiple precision product of an N-digit integer and an M-digit integer. This non-trivial problem is an excellent exercise for better students. For the majority of students, the importance of the mathematical concepts more than justifies two or three periods of class development of this program.

On the simplest level, we are going to develop a program to multiply A (containing N digits) times B (containing M digits) to obtain the product D (containing up to N + M digits). For example, we can multiply 31647 times 423 to obtain the product 13386681.

A traditional way of approaching the development of this program is to consider a specific example.

```

31647—A
• 423—B
94941
63294
126588
13386681—D

```

We would next try to generalize the procedures of the specific example. If we are successful, our generalization will work for any integer product. This approach will certainly work, but replicating the conventional hand procedures for multiplication requires considerable intermediate storage space.

In the previous example, A, B and D required 16 digits, but the three intermediate products also consumed 16 digits. For larger products, the use of intermediate storage far exceeds the storage used

for the values in which we're interested. We are, therefore, going to look at multiplication in a somewhat different manner. Our new perspective will not require the use of memory for intermediate storage. As a result, your 16K microcomputer can calculate and print the exact product of two integers, each of which contains almost 2000 digits.

We can begin with the easy part. The numbers to be multiplied will be entered using the same method illustrated in Listing 1.

```

10 DATA 5           number of digits in A
20 DATA 3           number of digits in B
30 DATA 3, 1, 6, 4, 7 the actual digits of A
40 DATA 4, 2, 3     the actual digits of B
50 READ N,M
60 DIM A(N), B(M), D(N+M)

```

Each subscripted value of A will contain one digit of the number A. Similarly, subscripted values of B each contain one digit of the number B. The subscripted values of D contain not only digits of the final product, but also all digits of nearly all intermediate computation. Notice

```

10 DATA 3
20 DATA 5,1,7
30 DATA 4
40 READ N
50 DIM D(N+1)
60 FOR I=N TO 1 STEP -1
70 READ D(I)
80 NEXT I
90 READ M
100 C=0
110 FOR I=1 TO N
120 P=D(I)*M+C
130 C=INT(P/10)
140 D(I)=P-C*10
150 NEXT I
160 D(N+1)=C
170 PRINT "THE PRODUCT IS:"
180 IF C>0 THEN N=N+1
190 FOR I=N TO 1 STEP -1
200 PRINT D(I);
210 NEXT I

```

Listing 1.

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Z80A-P10	7.10	4000	.35	4051	1.10	4532	1.25	74LS00	.35	74LS109	.45	74LS245	4.95
Z80-CTC	6.00	4001	.35	4052	1.10	4539	.99	74LS01	.28	74LS112	.49	74LS247	1.10
Z80ACTC	7.10	4002	.35	4053	1.10	4543	1.99	74LS02	.28	74LS122	.55	74LS248	1.10
Z80-DMA	18.50	4006	1.39	4055	3.95	4553	3.50	74LS03	.28	74LS123	1.19	74LS249	1.69
Z80A-DMA	22.50	4007	.29	4056	2.95	4555	.75	74LS04	.39	74LS125	1.35	74LS251	1.79
Z80-S10/0	18.50	4008	1.39	4059	9.95	4556	.75	74LS05	.28	74LS126	.89	74LS253	.98
Z80A-S10/0	22.50	4009	.49	4060	1.39	4581	1.99	74LS08	.39	74LS132	.79	74LS257	.98
Z80-S10/1	18.50	4010	.49	4066	.75	4582	1.01	74LS09	.39	74LS136	.59	74LS258	.98
Z80A-S10/1	22.50	4011	.35	4068	.35	4584	.55	74LS10	.28	74LS138	.89	74LS259	2.95
Z80-S10/2	18.50	4012	.29	4069	.35	4585	.99	74LS11	.39	74LS139	.89	74LS260	.69
Z80A-S10/2	22.50	4013	.49	4070	.49	4702	9.95	74LS12	.39	74LS145	1.25	74LS261	2.49
3205	3.95	4014	1.39	4071	.35	74C00	.39	74LS13	.47	74LS148	1.49	74LS266	.59
3242	10.00	4015	1.15	4072	.35	74C02	.39	74LS14	1.25	74LS151	.79	74LS273	1.75
8155	11.25	4016	.59	4073	.35	74C04	.39	74LS15	.39	74LS153	.79	74LS275	4.40
8185	29.95	4017	1.19	4075	.35	74C08	.49	74LS20	.26	74LS155	1.19	74LS279	.59
8185-2	39.95	4018	.99	4076	1.29	74C10	.49	74LS21	.38	74LS156	.99	74LS283	1.10
8202	45.00	4019	.49	4078	.35	74C14	1.65	74LS22	.38	74LS157	.99	74LS290	1.29
8205	3.95	4020	1.19	4081	.35	74C20	.39	74LS26	.39	74LS158	.75	74LS293	1.95
8212	2.00	4021	1.19	4082	.35	74C30	.39	74LS27	.39	74LS160	.98	74LS295	1.10
8214	3.95	4022	1.15	4085	1.95	74C32	.99	74LS28	.39	74LS161	1.15	74LS298	1.29
8216	1.85	4023	.38	4086	.79	74C42	1.85	74LS30	.26	74LS162	.98	74LS324	1.75
8224	2.65	4024	.79	4093	.99	74C48	2.39	74LS32	.39	74LS163	.98	74LS347	1.95
8226	1.85	4025	.38	4099	2.25	74C73	.85	74LS37	.79	74LS164	1.19	74LS348	1.95
8228	5.00	4026	2.50	4104	1.99	74C74	.85	74LS38	.39	74LS165	.89	74LS352	1.65
8238	5.45	4027	.65	4501	.39	74C85	2.49	74LS42	.79	74LS166	2.49	74LS353	1.65
8243	4.65	4028	.85	4502	1.65	74C89	4.95	74LS47	.79	74LS170	1.99	74LS363	1.49
8251A	5.55	4029	1.29	4503	.69	74C90	1.85	74LS48	.79	74LS173	.89	74LS365	.99
8253	9.85	4030	.45	4505	8.95	74C93	1.85	74LS51	.26	74LS174	.99	74LS366	.99
8255A	5.40	4031	3.25	4506	.75	74C95	1.85	74LS54	.35	74LS175	.99	74LS367	.73
8255A-5	5.40	4032	2.15	4507	.95	74C107	1.19	74LS55	.35	74LS181	2.20	74LS368	.73
8257	9.25	4033	2.15	4508	3.95	74C151	2.49	74LS73	.45	74LS190	1.15	74LS373	2.75
8257-5	9.25	4034	3.25	4510	1.39	74C154	3.50	74LS74	.59	74LS191	1.15	74LS374	2.75
8259A	7.30	4035	.95	4511	1.39	74C157	2.10	74LS75	.68	74LS192	.98	74LS375	.69
8271	60.00	4037	1.95	4512	1.39	74C160	2.39	74LS76	.45	74LS193	.98	74LS377	1.95
8275	32.95	4040	1.29	4514	3.95	74C161	2.30	74LS78	.65	74LS194	1.15	74LS385	1.95
8279	10.80	4041	1.25	4515	3.95	74C163	2.39	74LS83	.99	74LS195	.95	74LS386	.65
8279-5	10.80	4042	.95	4516	1.69	74C164	2.39	74LS85	1.19	74LS196	.89	74LS390	1.95
8282	6.70	4043	.85	4519	.99	74C173	2.59	74LS86	.45	74LS197	.89	74LS393	1.95
8283	6.70	4044	.85	4520	1.39	74C174	2.75	74LS90	.75	74LS221	1.49	74LS395	1.70
8284	5.85	4046	1.75	4522	.99	74C175	2.75	74LS92	.75	74LS240	1.95	74LS399	2.95
8286	6.70	4047	1.25	4526	1.15	74C192	2.39	74LS93	.75	74LS241	1.90	74LS424	2.95
8287	6.70	4048	.99	4527	1.75	74C193	2.39	74LS95	.88	74LS242	1.95	74LS668	1.75
8288	25.40	4049	.69	4528	.99	74C195	2.39	74LS96	.98	74LS243	1.95	74LS670	2.29
8289	49.95												

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that the number of digits required for all intermediate calculations will not exceed $N + M$, the number of digits needed to express the desired product.

Defining the subscripted values is done using:

```
70 FOR I=N TO 1 STEP -1
80 READ A(I)
90 NEXT I
100 FOR I=M TO 1 STEP -1
110 READ B(I)
120 NEXT I
```

Now let's examine a procedure that eliminates the need for excessive storage of intermediate results. The new procedure begins to differ with the first multiplication.

Standard procedure

2	
31647	
• 423	

1	

The 2 to be "carried" is recorded in a scratch area.

New procedure

31647	
• 423	

21	

The 2 to be "carried" is recorded in the appropriate position of the intermediate result. Notice that this is the position to which the carry would eventually be added using the standard procedure.

After 31647 is multiplied by 3, the results of both procedures will appear the same, but that is where the similarity ends. After then multiplying 7 by 2, the two procedures yield:

Standard procedure

1	
31647	
• 423	
94941	
4	

The 4 is recorded on a new line and the 1 to be "carried" is recorded in a scratch area.

New procedure

31647	
• 423	
941081	

This one isn't so obvious. The intermediate product was derived from

94	941
+	14
	941081

Certainly this number never appears using the standard procedure. In fact, since 10 occupies the space of a single digit, the number never appeared in anything in the student's background.

Continuing the new procedure, we multiply 4 by 2 and add the product to the appropriate digit of the intermediate result to produce

31647	
• 423	
95881	

Don't continue until you know why this intermediate product occurs.

After all digits of 31647 have been multiplied by 2, the two procedures appear as:

Standard procedure

31647	
• 423	
94941	
63294	

New procedure

31647	
• 423	
727881	

After all digits of 31647 have been multiplied by 4, the two procedures appear as:

Standard procedure

31647	
• 423	
94941	
63294	
126588	

New procedure

31647	
• 423	
13386681	

Notice that the new procedure has not only conserved storage space, but also the correct product is now known without additional computation. The BASIC commands required to implement this new procedure are:

```
140 C=0
```

```
150 FOR I=1 TO N
160 P=A(I)*B(K)
170 C=INT(P/10)
180 P=P-C*10
190 S=I+K-1
200 D(S)=D(S)+P
210 C1=INT(D(S)/10)
220 D(S)=D(S)-C1*10
230 D(S+1)=D(S+1)+C+C1
240 NEXT I
250 NEXT K
```

After understanding this algorithm, there remains only the task of printing the final product. Leading zeroes are first eliminated using:

```
260 N=S+1
270 IF N>1 THEN IF D(N)=0 THEN N=N-1 : GOTO 270
```

The complete program is given in Listing 3. Adding a line 235 that prints the values of all digits in D will help illustrate the intermediate values of the new procedure.

Factorials

The factorial of an integer is defined as the product of all integers 1 through the given integer. For example, 5 factorial is $1*2*3*4*5$, which equals 120. Calculating the exact value of large factorials is a natural extension of the program illustrated in Listing 3. The hard part has already been done in lines 130 through 250. We need only change the initial values and the output format to complete a program that calculates virtually any factorial we desire.

Listing 4 contains a program with all of the suggested changes. The program prints the factorials of all integers 1 through 999. Lines 10 through 40 set the

initial values, and lines 320 through 390 reset these values after each factorial is computed.

Don't miss the opportunity to share this program with students. Experience suggests that the majority of students enjoy first watching and then experimenting with the large numbers produced. The value of 999 factorial given in Fig. 1 was calculated using a similar program. Can you calculate the exact value of 1000 factorial without pencil, paper or computer? □

```
10 DEFINT A-Z
20 DIM D(1500)
30 N=1 : D(1)=1 : M=3
40 FOR K=1 TO 1690
50 C=0
60 FOR I=1 TO N
70 P=D(I)*M+C
80 C=P/10
90 D(I)=P-C*10
100 NEXT I
110 D(N+1)=C
120 IF C>0 THEN N=N+1
130 PRINT : PRINT : PRINT
140 PRINT " " K
150 PRINT "3"
160 PRINT
170 FOR I=N TO 1 STEP -1
180 PRINT D(I);
190 NEXT I
200 NEXT K
```

Listing 2.

```
10 DATA 5
20 DATA 3
30 DATA 3,1,6,4,7
40 DATA 4,2,3
50 READ N, M
60 DIM A(N), B(M), D(N+M+1)
70 FOR I=N TO 1 STEP -1
80 READ A(I)
90 NEXT I
100 FOR I=M TO 1 STEP -1
110 READ B(I)
120 NEXT I
130 FOR K=1 TO M
140 C=0
150 FOR I=1 TO N
160 P=A(I)*B(K)
170 C=INT(P/10)
180 P=P-C*10
190 S=I+K-1
200 D(S)=D(S)+P
210 C1=INT(D(S)/10)
220 D(S)=D(S)-C1*10
230 D(S+1)=D(S+1)+C+C1
240 NEXT I
250 NEXT K
260 N=S+1
270 IF N>1 THEN IF D(N)=0 THEN N=N-1 : GOTO 270
280 PRINT "THE PRODUCT IS:"
290 FOR I=N TO 1 STEP -1
300 PRINT D(I);
310 NEXT I
```

Listing 3.


```

10 DEFINT A-Z
20 DIM A(3000), B(3), D(3000)
30 A(1)=1 : B(1)=1
40 N=1 : M=3
130 FOR K=1 TO M
140 C=0
150 FOR I=1 TO N
160 F=A(I)*B(K)
170 C=INT(F/10)
180 F=F - C*10
190 S=I+K-1
200 D(S)=D(S) + F
210 C1=INT(D(S)/10)
220 D(S)=D(S) - C1*10
230 D(S+1)=D(S+1) + C + C1
240 NEXT I
250 NEXT K
260 N=S+1
270 IF N>1 THEN IF D(N)=0 THEN N=N-1 : GOTO 270
280 PRINT 100*B(3)+10*B(2)+B(1) "FACTORIAL IS:"
290 FOR I=N TO 1 STEP -1
300 PRINT D(I);
310 NEXT I
320 FOR I=1 TO N
330 A(I)=D(I)
340 D(I)=0
350 NEXT I
360 PRINT : PRINT
370 B(1)=B(1)+1 : IF B(1)<10 THEN 130
380 B(1)=0 : B(2)=B(2)+1 : IF B(2)<10 THEN 130
390 B(2)=0 : B(3)=B(3)+1 : IF B(3)<10 THEN 130

```

Listing 4.

```

402 387260 077093 773543 702433 923003 985719 374864 210714 632543
799910 429938 512398 629020 592044 208486 969404 800479 988610 197196
058631 666872 994808 558901 323829 669944 590997 424504 087073 759918
823627 727188 732519 779505 950995 276120 874975 462497 043601 418278
094646 496291 056393 887437 886487 337119 181045 825783 647849 977012
476632 889835 955735 432513 185323 958463 075557 409114 262417 474349
347553 428646 576611 667797 396668 820291 207379 143853 719588 249808
126867 838374 559731 746136 085379 534524 221586 593201 928090 878297
308431 392844 403281 231558 611036 976801 357304 216168 747609 675871
348312 025478 589320 767169 132448 426236 131412 508780 208000 261683
151027 341827 977704 784635 868170 164365 024153 691398 281264 810213
092761 244896 359928 705114 964975 419909 342221 566832 572080 821333
186116 811553 615836 546984 046708 975602 900950 537616 475847 728421
889679 646244 945160 765353 408198 901385 442487 984959 953319 101723
355556 602139 450399 736280 750137 837615 307127 761926 849034 352625
200015 888535 147331 611702 103968 175921 510907 788019 393178 114194
545257 223865 541461 062892 187960 223838 971476 088506 276862 967146
674697 562911 234082 439208 160153 780889 893964 518263 243671 616762
179168 909779 911903 754031 274622 289988 005195 444414 282012 187361
745992 642956 581746 628302 955570 299024 324153 181617 210465 832036
786906 117260 158783 520751 516284 225540 265170 483304 226143 974286
933061 690897 968482 590125 458327 168226 458066 526769 958652 682272
807075 781391 858178 889652 208164 348344 825993 266043 367660 176999
612831 860788 386150 279465 955131 156552 036093 988180 612138 558600
301435 694527 224026 344631 797460 594682 573103 790084 024432 438465
657245 014402 821885 252470 935190 620929 023136 493273 497565 513958
720559 654228 749774 011413 346962 715422 845862 377387 538230 483865
688976 461927 383814 900140 767310 446640 259899 490222 221765 904339
901886 018566 526485 061799 702356 193897 017860 040811 889729 918311
021171 229845 901641 921068 884387 121855 646124 960798 722908 519296
819372 388642 614839 657382 291123 125024 186649 353143 970137 428531
926649 875337 218940 694281 434118 520158 014123 344828 015051 399694
290153 483077 644569 099073 152433 278288 269864 602789 864321 139083
506217 095002 597389 863554 277196 742822 248757 586765 752344 220207
573630 569498 825087 968928 162753 848863 396909 959826 280956 121450
994871 701244 516461 260379 029309 120889 086942 028510 640182 154399
457156 805941 872748 998094 254742 173582 401063 677404 595741 785160
829230 135358 081840 096996 372524 230560 855903 700624 271243 416909
004153 690105 933983 835777 939410 970027 753472 000000 000000 000000
000000 000000 000000 000000 000000 000000 000000 000000 000000 000000
000000 000000 000000 000000 000000 000000 000000 000000 000000 000000
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```

Fig. 1. The value of 999 factorial.

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Name Games

As a service to the businessmen among our readers, *Microcomputing* has devised a quick and simple (some might even say dirty) method for naming new products and companies.

Table 1 lists 26 prefixes and 26 suffixes for your use. Simply attach any entry in the first column to any entry in the second, and voila! You have yourself an instant name.

The table provides 668 possible combinations (676, less eight such doubles as Datadata and Videovideo). But if you still aren't satisfied, here are some ways to enlarge the pool:

1. If you're naming a product, stick a number at the end of it. Four-digit numbers ending in three zeros are very contemporary. For example, the Electrometrics 2000.

2. For extra pizzazz, try putting a capital letter in front of one of the suffixes, separating them with a hyphen: M-Comp, T-Flex, G-Net. If you don't like hyphens, slashes are becoming de rigueur. (Using both hyphen and slash—R/B-Type, for example—is considered gauche.)

3. To give your company that high-powered, high-tech profile, put one of the following after the name: International, Research, Systems, Group. In fact, if you want to get really macho, use all four.

4. Finally, if you prefer a more informal image, sandwich your choice between your first name and either Shack or Palace: Willie's Microfax Shack, Bob's Plexiplus Palace. The word Emporium is no longer stylish, although some observers think that Barn is about to make a big comeback.

* * * * *

Speaking of names, has anyone noticed that the data communications industry has gone bonkers for the suffix *-net*? A quick survey of a few of the trade journals uncovers such examples as MicroNet, Miconet, Texnet, PETnet, Apple-net, Ethernet, Fordnet, Tymnet, Telenet, Primenet, Macomnet, B/C-Net, Mitrenet, and TerminiNet. Pretty soon we'll need a Netnet to keep them all straight.

* * * * *

Microcomputing's authors have recently shown an increasing fondness for the word generate. Computerists don't seem to think anymore: they generate ideas. Those with word processors no

longer write; they generate copy. For example, a recent manuscript included the line, "New lead material was generated for the Chicago story."

Generate is a perfectly good verb, and can be effective when used in the right place at the right time. But it is one of an increasing number of crossover words that are being applied to both the human and the computer experience. (Others include interface for talk, data bank for memory and input for information.)

I, for one, prefer to maintain the distinction between man and machine, both in thought and in language. As Melvin Maddocks put it in a recent issue of the *Christian Science Monitor*:

"Until a computer falls in love or laughs at a bad pun or weeps at what its 'memory bank' tells it in the middle of the night, we humans should avoid all but the most limited of comparisons in both directions."

* * * * *

Old Words Learning New Tricks Dept.

Prefixes	Suffixes
Compu	data
Tele	soft
Multi	micro
Data	ram
Inter	net
Digi	com
Auto	type
Uni	tech (tek)
Video	mation
Info	writer
Soft	tex
Mega	serve
Astro	graphics
Micro	fax
Opti	tronix
Dyna	tel
Plexi	plus
Ram	con
Com	file
Techno	plex
Con	comp
File	flex
Insta	video
Meta	calc
Electro	link
Alpha	metrics

Table 1.

Give Your Product The Moniker It Deserves

—From The Interface Group in Framingham, MA, comes a news release with this heading: "Interface Group Pacts with Little Bros." Close, but no cigar—while impacts is a certified verb, pacts is not. Until somebody comes up with a good reason why it should be otherwise, a pact is still a thing, and it must be made, agreed to or in some way acted upon.

This next one comes from an article in *Computer Systems News*: "A new round of entrepreneurial companies entered the arena, while mature companies continued to ramp up production on both new and established products." This is more confusing than the Interface Group example, for while ramp can be used as a verb, none of its dictionary meanings makes any sense here: "to rear as if to spring," "to leap or dash with fury," "to act violently; rage; storm," "to creep up—used esp. of plants."

From the context, one can deduce that ramp up is being used as a synonym for increase. But this leads to another question: why didn't the author simply use the word increase?

Finally, Aaron Contorer of Deerfield, IL, writes to say that he and a number of CBM operators, all hooked up to one disk drive and a couple of printers, are using the verb disk-ing to indicate when one of them is using the disk drive.

"If any two of us try to print or access the disk drive at the same time, the signals will foul each other up, possibly messing up printouts and erasing or changing disks," he says. "To avert disaster, we have invented the word disk-ing. This is a plain enough word, meaning 'to use the disk drive.' It is probably a spin-off from the word printing, and is much simpler than saying 'going to disk' or 'using the disk drive.'"

People often capriciously alter the meaning of a word because they are sloppy or ignorant. Here is a good example of an adaptation being made to meet a specific situation or need. Disk away, gang.

* * * * *

Speaking of disks, is it possible that someday we'll have antiquarian disk dealers and Great Disk Societies? That college students will hit the disks when studying? That criminals will be hauled off to the precinct to be disked? That the Bible will be referred to as the Good Disk? Just asking. . . . □

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Private Schools

Micros Go Catholic in Texas, Omaha

Private Schools Go Micro

Students at Nolan Catholic High School in Fort Worth, TX, will soon be required to take a microcomputer course if they want to graduate.

The computer literacy program, which starts with the graduating class of 1984, is the direct result of a new computer center donated to the school by several anonymous benefactors. The school, with an enrollment of about 750 students, owns 21 TRS-80 microcomputer systems.

The program has been a big hit with the students so far, says Brother Tony Pistone, Nolan's principal. Some 160 students were enrolled in the one-semester course this past spring, and Brother Tony expects some 220 to take it this fall.

"The computer center is very attractive and centralized," he says. "It's different from classrooms. Students see the possibilities, and it opens a lot of creative avenues for them."

The program developed last year with the help of Brother Eugene Meyerpeter, a computer education specialist from St. Louis, MO. "He told us what it would take, and we submitted this proposal to our benefactor," says Brother Tony. The school placed 15 Model I's in the computer center and two in math classes. Model IIs are being used for attendance records and for payroll and accounting.

Brother Tony says that a couple of math teachers taught the computer course this spring. "But next year we hope to have a full-time teacher who will not only teach the course, but will also help our other departments and faculty to use the computers."

Nolan is also using the computers for adult education courses.

"Some of the parents didn't want the kids to get too far ahead of them," Brother Tony says.

Nolan is not the only Catholic school to be embracing microcomputers. Brother Eugene, who did Nolan's needs assessment, is the new principal at Daniel J.

Gross High School in Omaha, NE. That school, with an enrollment of about 1300, will double the number of TRS-80 Model I's it has to 15 or 16, and will use Model IIs for its administrative work.

Brother Eugene is firmly committed to the teaching of microcomputer technology in elementary and secondary schools. "It's vitally important that students be alerted to the importance computers will have in their lives after they graduate," he says.

Daniel J. Gross High School currently has no computer literacy requirement, but Brother Eugene says that he is "cer-

tainly going to ask the faculty to consider it." But he cautions that the requirement "must be defined very carefully. I don't think it's feasible to think that all students have, or should have, the same educational needs."

Computer education, he says, "really involves a question of responsibility. It's trite to say this, but it's true: people blame computers for problems that people are responsible for. It should be part of the educational process to change this way of thinking."

Both Brothers Tony and Eugene agreed that teachers are more intimidated by



The computer center at Nolan Catholic High School in Fort Worth, TX, includes 15 TRS-80 Model I's. Starting with the graduating class of 1984, students must take a one-semester course in microcomputers.

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the computers than students are.

"Teachers are afraid of them," Brother Tony says. "It's amazing to me, but they are afraid of them."

"There's a whole group of teachers out there who don't even know that this technology exists," says Brother Eugene. "This is what scares me. Business has turned to the computer because of dollars, and has run with it, and it has created a real gap between the business and educational communities."

Are private schools better-equipped to provide the kind of computer literacy Brother Eugene says high school students will need? Probably, he says.

"My bias is that we're much more flexible, because there's less bureaucracy to get around. The schools within each archdiocese are connected, but they are pretty autonomous."

"I've met some very frustrated public school educators who would like to get into it, but can't."

Software Industry Forges (Shakily) Ahead

A recent report from International Resource Development in Norwalk, CT, depicts the software industry as being in constant chaos and flux, but says that it will reach \$2 billion in sales by 1985.

The report says that one-person software houses will continue to rise and fall with the tides, and that many venture capitalists will pour millions of dollars into marginal software houses. Thus, says the report, consumers will continue to be the recipients of poor-quality software, until a predicted shakeout around 1983.

The study also says that while the Japanese will take a significant bite out of the hardware market, software will come largely from American manufacturers. The report says that at least two software firms—Friends-Amis and Microsoft—have software contracts with Japanese microcomputer manufacturers. The Japanese will end up with significantly less than half the hardware/software market, says the report, since software will eventually outsell hardware.

The report also concludes that large outfits like IBM, Hewlett-Packard, DEC, Data General and Texas Instruments will dominate the small business software market, while such companies as Radio Shack, Apple and Commodore will scramble for the scraps.

Another report, this one from Venture Development Corporation of Wellesley, MA, says that the business microcomputer market will see an annual growth rate of about 52 percent between now and 1985. The other three major markets—education, engineering/science and home/hobby—will grow at annual rates of 34, 30 and 26 percent, respectively.

The report concludes that total annual shipments of microcomputers will increase from 400,000 in 1980 to 2 million in 1985.

1981

- IBM introduces its System 380, an under-\$3000 personal computer with the power of the IBM 370 mainframe.

1982

- Japanese manufacturers launch major invasion of home computer market with powerful personal computers that are compatible with the enormous existing base of Microsoft BASIC and CP/M software, and cost less than \$300.
- Knight-Ridder and AT&T announce a nationwide joint viewdata service.
- The United American Service Corp., CompuServe and Radio Shack sell their 500,000th electronic banking-at-home system.
- High-performance, low-cost integrated video terminal for sale.
- Program generators eliminate shortage of programmers, but shortage of capable systems analysts persists.

1983

- All major print publishers either begin software divisions or acquire shares in important software providers.
- All major toy and hobby companies establish software divisions.
- First \$100 million-a-year software house.

1985

- The 1000th computer software shop opens.
- Manufacturers agree to standards for systems software and high-level languages.
- English-language programming captures vast majority of software market.

International Resource Development's scenario for microcomputer software, 1981-86.

	No. of Micros Installed (year-end)	Annual Software Unit Sales	Annual Retail Value of Software Sold
1979	250,000	1,000,000	\$200 million
1981	750,000	2,150,000	600 million
1983	2,000,000	4,750,000	950 million
1985	4,500,000	10,000,000	2.0 billion
1987	10,125,000	25,300,000	5.1 billion
1990	33,750,000	100,000,000	25.0 billion

Potential sales of microcomputer software through 1990. (Source: International Resource Development, Inc.)



One of England's famed double-decker buses has become a rolling billboard for Datalink Microcomputer Systems Ltd. of Bristol. The design was created by Wedge Wilson Marketing Services Ltd., also of Bristol.

The Insight Series 10

Texas Instruments has entered the videotext terminal market with the Insight Series 10 Personal Information Terminal.

The terminal, which is 12 inches high and has a 5-1/2-inch swivel display screen, is used to access various electronic information services like CompuServe and The Source.

The Series 10, which TI bills as "designed for the nontechnical user," has a built-in modem and plugs into a standard modular wall telephone jack and into the telephone. The user dials a telephone number, types in the log-on sequence and is on-line. A talk/data switch gives the user normal telephone use when required.

The screen has a 24-row by 40-character format, with a wrap-around feature when 80-column transmission is received. An optional command module can store up to eight prerecorded functions, with 32 characters per function.

The Series 10 comes with an EIA RS-232-C interface, and a limited RS-232-C interface for hard-copy printouts.

TI is also marketing an Insight Series 10/1 receive-only thermal printer.

Both the Series 10 and the Series 10/1 are priced at \$995.

CompuPro Recall

CompuPro, a division of Godbout Electronics, has issued a general recall of its CPU 8085/88 dual processor board that contains 8085A-2 CPU chips manufactured by AMD. The chips are marked as 5 MHz parts, but are actually only 3 MHz parts. They are marked AM8085A-2CC (ceramic package) and AM8085A-2PC (plastic package).

Boards that contain 8085s from Intel are not subject to recall.

Customers who bought their boards assembled and tested should return the board and the AMD part will be replaced. If the board was bought unassembled, you should return the part for a replacement.

Owners of CSC boards should already have received replacement boards.

For assistance or information, contact CompuPro, PO Box 2355, Bldg. 727, Oakland Airport, CA 94614 (415-562-0636).

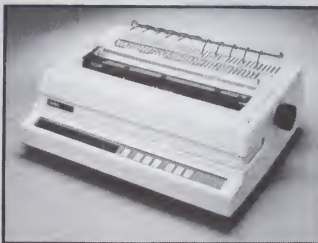
Micros to China

The People's Republic of China is buying up to \$5 million worth of Z-80 based small business microcomputers from Zilog, Inc., of Cupertino, CA.

The Beijing Automation Technology Research Institute will be using MCZ 1/50 microcomputer systems for airline and hotel reservation systems and for educational purposes at universities.

Zilog is training several People's Republic representatives to use the computers and their software. □

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LETTERS TO THE EDITOR

Pocket Computer Benchmarks

I noted with interest Nat Wadsworth's article on the TRS-80 Pocket Computer (PC) in the February 1981 issue of *Microcomputing* (p. 162). I recently purchased in Japan a Sharp PC-1211, which is the same as the TRS-80 PC except the PC-1211 has a yen sign (¥) over the Y key.

Wadsworth used the benchmark timing comparisons from the June 1977 issue of your magazine ("BASIC Timing Comparisons, p. 66) to rank the PC. I submit this is like comparing apples to oranges, and thus serves as a limited yardstick for comparison.

Perhaps a better comparison could be made between the PC and Hewlett-Packard's HP-41C or the Texas Instruments TI-59. These three instruments have similar amounts of memory, speed, program storage ability, options and price tags. (The PC I bought can be outfitted with a cassette interface/printer that plugs into the side of the PC and is only slightly larger than the PC itself.)

Some highlights of the features of the PC include the ability to read and write both programs and data through the cassette interface. The PC has the ability to use labels instead of line numbers for program transfer; it supports nested subroutines, formatted output, dimensioned variables and string variables; and it doesn't forget when the power is turned off.

In a recent article in *Byte* (December 1980, p. 244), the comparison was made by Bruce D. Carbrey between the HP-41C and the TI-59 on two different benchmark programs. I would like to include my findings on how the PC measured up to the first benchmark so your readers can judge among the three machines. (See Table 1.)

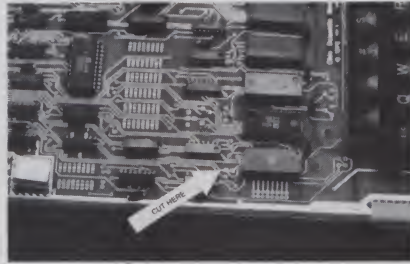


Photo 1.

Note that the PC-1211 doesn't walk away from the competition. When you consider, though, that the programs are written in BASIC, you have full editing and debugging ability and there are many features and options available that contribute to its ease of use and programming, then you have a strong inducement to consider the PC before buying a machine that falls into the category between a microcomputer and a programmable calculator.

Scott U. Johnson
San Francisco, CA

A Simpler Modification

Jim Antonelli in his C1P speedup article ("Faster Baud Rate for the Superboard II," March 1981, p. 112) did a good job on the article, and the modification is a good one. It works! However, it's not as simple as it could be.

In Fig. 1, pin 9 of the U63 is the normal TX clock, which feeds the 6850 ACIA to give the nominal 300 baud cassette interface. U63 is a D flip-flop, so the signal at pin 11 is twice the frequency of the clock at pin 9.

The simplest 600 baud modification involves making only one printed circuit cut (see Photo 1) above the common con-

nection at W5 just above the 6850. This breaks the clock line to the ACIA. Now wire in an SPDT switch so the common terminal connects to the ACIA clock and the two positions select either the normal clock from U63, pin 9, or the 2X clock from pin 11.

Since the tones being generated using this technique are the same as the original, there is no need for the extra work to modify the receive side of the cassette interface. The venerable Kansas City standard used by OSI has so much redundancy that having only half as many cycles of each tone makes virtually no difference in the effectiveness of the interface.

I've been using this for almost two years, and when I have a problem loading a tape it means it's time to clean the tape machine.

Curtis A. Preston
Shalimar, FL

More on Zero Numbering

In commenting on zero numbering (Letters to the Editor, April 1981, p. 29), William McGarry uses an example of using disk track numbers as indices into a table in claiming that "if the first track was track #1 instead of track #0, then either one would have to be subtracted from the track number before indexing, or the first entry in DDATA would have to be filled with dummy data to obtain the proper entry... this would mean lost memory, speed and efficiency."

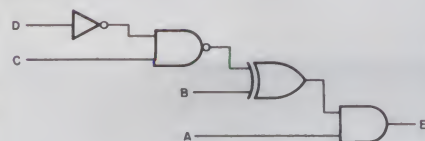
This is indeed true if the subtraction is done at execution time with this code sequence: load track number, subtract one, add address of DDATA, fetch from memory.

If, however, you allow the assembler to do the subtraction, there is no loss in exe-

(continued on page 211)

MICRO QUIZ

Find all combinations of binary inputs (A,B,C,D) which make E true.



(continued on page 184)

Problem: Calculate bond yield using this formula:

$$P = I \sum_{J=1}^N (1+Y)^{-J} + M(1+Y)^{-N}$$

Data: M = 20,000, I = 1400, N = 50, Y = 8%
Answer: P = 17,533.30

	Time (sec)	Results: Memory used	% of total memory	# of lines
TI-59	43	59 steps	10.3	59
HP-41C	37	41 bytes	15.6	31
PC	51	83 steps	5.8	7

Table 1.

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ENGINEERING AND PRODUCTION CONTROL SYSTEMS



Company founder and president, Walter L. Myers (right), pictured with production engineer Joe Zellers who developed the production control software for the MSI computer system.

system. Since 1975, the MSI system has been expanded to accommodate four users simultaneously, performing a variety of plant monitoring functions and management programs."

"The system is equipped with 10 megabytes of hard disk storage presently and we plan to add an additional 10 megabytes of storage soon. The maximum downtime has been only one or two days in the 5 years that the system has been in operation. MSI has provided excellent technical support and willingness to help us with our special requirements. We have nothing but praise for MSI, they have provided excellent system support."

SPRING ENGINEERING AND DESIGN

"All of the production at Myers Spring is performed to exact customer specifications rather than to the manufacture of standard spring products. This causes an ever increasing demand for quick and efficient design and engineering capabilities. Many parameters have to be taken into consideration in the design of any particular spring, including wire size, wire type, material modulus, spring diameter, number



One of four workstations where design engineering, checking of sales order status, and production control monitoring is performed.

THE COMPANY:

**MYERS SPRING COMPANY, INC.
LOGANSPOUT, INDIANA**

Myers Spring Company, Inc. was founded 35 years ago by Walter L. Myers for the manufacture of small mechanical springs which are used widely in mechanical appliances, electrical equipment, and by the automotive, construction, and many other industries. The Myers Spring company has grown to several million dollars in annual sales and employs approximately 50 people in its production facility.

Production engineer Joe Zellers comments, "we began looking at computer systems approximately ten years ago in order to keep up with the increasing demand of order processing, custom mechanical spring design engineering, and production control. In 1975, we selected the MSI system because they were the first company in the microcomputer industry to offer the necessary peripherals which would convert a microcomputer system into a usable business



The production facility at Myers Spring Co. is equipped with many automated machines for mechanical spring production.

of turns per inch, free length, spring loading, rate, solid height, working stress, working temperature, number of operating cycles, hysteresis, resonant frequency, expansion, and whether the spring has to be ground or not. It used to take over an hour for an engineer to design a spring taking into account all of these parameters. However, with the engineering software which we have developed for the MSI system, spring design can be completed in less than one minute by simply keying in the desired parameters. The MSI computer system not only designs the spring for us but prepares a complete quotation for the customer after consideration of the material to be used, the amount of waste, which equipment the production will use, the speed of the machines, the necessary labor rate, as well as the desired percentage of profit."

SALES QUOTATION SYSTEM

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PRODUCTION CONTROL/JOB COST ACCOUNTING

Each production work order is tracked by the computer system at each stage of the production process. First, each order is checked against the customer quotation for accuracy. As each order is processed, exact shop labor time is recorded, for each production machine used, and each stage of the production process. Summary reports are produced showing the total amount of material used, time used on each production machine, amount of material used, and a total cost figure for each work order.

SALES SUMMARY REPORTS

The system is designed to produce monthly sales summaries which show the amount of products sold by each salesman, complete with dates, order numbers, type of product, quantity, type of material, material cost, sales commissions, etc. Totals for each desired category and for each salesman are reproduced.

ACCOUNTS RECEIVABLE SYSTEM

Each morning, invoices are generated for orders which will be shipped that day. The accounts receivable system maintains accounts for over 500 active customers. The system produces monthly statements complete with aging of open invoices.

MULTI USER CAPABILITY

The MSI system is equipped with four user terminals presently which are available for use simultaneously by the following departments: Order department, for entering new orders and checking order status. Inventory department, used for checking to see whether a particular product has been produced previously. Invoicing/Cost Accounting, used for preparation of invoices and for entry of labor and material cost accounting information. Design Engineering, used by company engineers to design new products.



Order entry, invoicing, monthly statements, and other management reports are carried out at this workstation at Myers Spring Co.



The MSI system at Myers Spring Company is equipped with 10 megabytes of hard disk memory, dual floppy disk drives, a high speed printer, and four user CRT terminal workstations.

GENERAL LEDGER TIE-INS

The MSI system automatically prepares journals for cost accounting information and sales data which can then be posted to the general ledger. Complete income statements and balance sheets are produced by the general ledger programs on the system.

MULTIPLE MANAGEMENT REPORTS

The MSI system is used in many different areas of the company in order to provide more efficient and effective management of our production facilities. Several of the reports which we obtain from the system are: **production schedules, due list for orders, new orders list, production summary by department, salesman's reports, individual customer reports and order histories, time studies, sales quotations, design engineering, sales summaries, customer statements, general ledger balance sheet and income statements.**

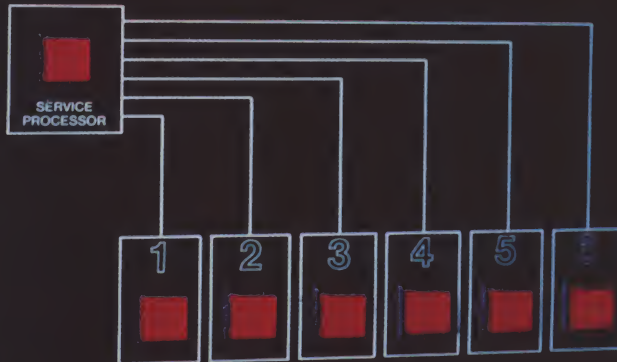
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Which Multi-User Approach:

DISCOVERY MULTIPROCESSOR



ACTION COMPUTER ENTERPRISE, Inc. Pasadena, California

The Discovery Multiprocessor from Action Computer Enterprise. S-100 bus and CP/M compatible, this computer supports six user terminals and one printer. Each user has his own CPU and memory, with an additional service CPU providing communications and peripheral handling.

Act I Scene i

It is late at night in the offices of Cribble, Freres, & Brothers, attorneys-at-law. An overtime crew is working furiously to prepare the 14 pages of text that compose a pleading in the case of Grimmich vs Crimwad-dy. The document must be perfectly phrased, flawlessly typed and in the hands of Judge Meanie of the District Circuit Court of Dismissals first thing the next morning, if their client's case (or maybe even their client) is to survive.

Anne Attorney sits at her desktop word processing computer, with its whirring fan and buzzing floppy disk drives. She has spent hours composing the text of the pleading. As she completes the last page, she turns to Joe Steno, who sits, bored, at his text formatting/printing computer across the room.

"Joe, here's the pleading. Patch in the standard header, get all the names consistent, and type a rough draft." Anne removes the disk containing the text and holds it out toward Joe.

Joe shuffles across the lavishly carpeted office and reaches for the disk. As their hands come close, molecules are ionized and a static discharge arcs from Joe's hand to Anne's. The static finds a path to ground through Anne's other hand, which is resting on the keyboard of her computer. On its way, the discharge converts all of the contents of memory in her computer to "00 39."

The spark also causes a reflex action in Joe's arm, and he drops the flexible disk onto Anne's overflowing ashtray. Mylar and millions of bits of data melt on the glowing tip of her burning cigarette.

All is lost.

Act II Scene i: Another Time

ENTER: The multi-user microcomputer

Anne sits calmly at her silent terminal, composing the pleading in the continuation of the Grim. vs Crim. case. As she completes the first page of text, she presses the button on her intercom.

"Joe," she whispers seductively, "the first page of the text is on the hard disk as 'GRIM-1.TXT.' Patch in

header format 3 and replace all the occurrences of '*G*' with the plaintiff's full name. Page two should be on the disk before you are done."

Act II Scene ii: One Hour Later

Minutes after Anne has finished composing the final page of the document, Joe enters her sanctum with her coffee and the final draft of the 14 pages, neatly formatted and typed by the computer.

* * * * *

The preceding fictional nonsense serves to illustrate one of the many advantages inherent in the use of a multi-user microcomputer. As microcomputers proliferate in the worlds of business, law and science (to name just a few applications), more and more instances occur in which it would be desirable to have more than one user working with the same database at the same time.

Ken Barbier (Borrego Engineering, PO Box 1253, Borrego Springs, CA 92004) is a Microcomputing associate editor. His most recent article is "A Print Utility for CP/M," in the February issue.



Multiprocessor or Multitask?

By Ken Barbier

The System 40 from Integrated Business Computers. While shown with two CRT terminals and one printer, the IBC computer supports four user terminals and two printers at the same time. The basic computer comes with two double-density, double-sided floppy-disk drives. A 20 Mbyte hard disk can be added.

This mode of operation has traditionally been the province of the large mainframe computer with its megabuck price tag. But as hardware prices plummet, it becomes economically feasible for even the smaller businesses or law offices to own a multi-user microcomputer suitable for accounting, word processing, inventory or production control.

But just what is a "multi-user" computer?

Some Definitions

A computer which can support multiple users working independently at multiple terminals, each having complete access to all of the resources of the machine, is defined as a *multi-user* computer (terms in italics are further defined in the Glossary). If a computer has multiple terminals attached, but the terminals can only be used for dedicated applications, such as logging production line output or parts usage, it is a *multiterminal* computer, which is obviously not the same.

Several techniques in both hardware and software have evolved to

support a multi-user environment. The traditional method, *multitasking*, uses a single central processing unit (CPU) to handle the programs for all of the users. A pulse generator causes periodic interrupts to occur, and at each interrupt the *task scheduler* stops the program in progress, saves its context and enables the next task, and therefore the next user, to run his program on the CPU. Each user in turn is given one interrupt-defined *time slice* in which to use all of the resources of the CPU. At the end of the current user's time slice, he is put on hold by the scheduler, and the next user gets to run his program.

Since each time slice is only a few ms, it appears to the users that they are all running simultaneously. This word is often misused in reference to multitask systems. Tasks do not run at the same time; they only appear so to us slow humans. Tasks actually execute sequentially in such a system.

For the users to run their programs simultaneously, a *multiprocessor* computer is required, where each user has his own CPU hardware, and only

shares such resources as mass storage and line printers. Since each user has full-time access to his own CPU, this method requires one additional control CPU running a supervisory or executive program to handle the shared resources.

Which Method Is Best?

A multitask system makes most efficient use of hardware resources. Memory space can be dynamically allocated to each user according to his needs. If the operating system is properly written, system programs such as an assembler, BASIC or FORTRAN languages, or a word processor are *reentrant*. This means that more than one user can run the same system program at the same location in memory, sharing the program in time slices just as they share the CPU.

Non-reentrant programs require a separate memory image of the program for each user, and this can eat up a lot of memory space in a hurry. For instance, if four users each want to program in BASIC, a non-reentrant version of a BASIC interpreter has to be replicated four times in four dif-

ferent areas of memory. This typically takes up about 80K of memory, even without the user's programs!

In addition to the desirability of reentrancy, there is the requirement that all programs for use in a multitask system be *relocatable*. This means that they must be able to be loaded into memory at any address and still execute properly.

In either case, the multitask operating system (MTOS) has a lot of work to do, and the MTOS itself will require a large part of the available memory space. In a small system it will be almost imperative for the MTOS to support *virtual storage* (VS). A simple example of VS is incorporated in most word processor programs. All of the text in a document file is not in memory at any one time. Blocks of

text are swapped from disk to memory as needed, without any interaction needed on the part of the user. To the user, the memory available appears to be virtually infinite. The same technique can be used to execute programs that are larger than the memory space available.

To avoid the large software overhead of the MTOS, it is possible to build a multiprocessor where each user has a CPU and a memory map

that is identical to that in a single-user system. This would permit running all of that old non-reentrant, non-relocatable software. The extra cost involved is in hardware, since now each user needs his own physical memory (as opposed to virtual memory), as well as his own CPU.

As prices of integrated circuits (ICs) continue to drop, multiprocessors become more cost effective, competing with the traditional multitask sys-

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Glossary

Not every term in the computer industry (or any other!) is so cast in concrete that a single definition can explain all usages or satisfy all users. The definitions given here apply to the types of computer systems covered in this article. Alternate definitions can sometimes apply in other contexts. For instance, some multiprocessors have many CPUs working on the same problem at the same time.

Batch processing—The execution of programs one at a time, where the first program runs to completion before the second can start.

Multiprocessor—A computer system providing each user with his own central processing unit (CPU) and memory. Mass storage (tape or disk drives) and peripherals such as line printers are shared by all users, and are controlled by an additional CPU, the service processor.

Multitask (also multiprogram)—An operating system permitting more than one program to run on a single CPU. Each program in turn is given a small time-slice in which to execute, giving the appearance to the user that all tasks are executing at the same time.

Multiterminal—A computer to which more than one terminal device can be connected. The additional terminals do not have full computational capabilities as is true for a multi-user system.

Multi-user—A computer permitting more than one user to have access to all of the resources of the system at the same time.

Print spooling—The technique of automatically outputting files to the printing device without user

intervention. Once print requests are specified, the users can proceed with other tasks while the spooler program handles the slow printing.

Reentrant—Programs or program segments written to permit their use by more than one task at a time. Each task must supply its own data area in memory, and provide the reentrant routine with a register pointing to that area, so that an interrupting task will not modify another task's data.

Relocatable—Programs that, after being assembled or compiled, are in a format that permits their being loaded into memory and executed at any memory address.

Service processor—In a multiprocessor computer, the additional CPU which controls interprocessor communications and the common peripherals.

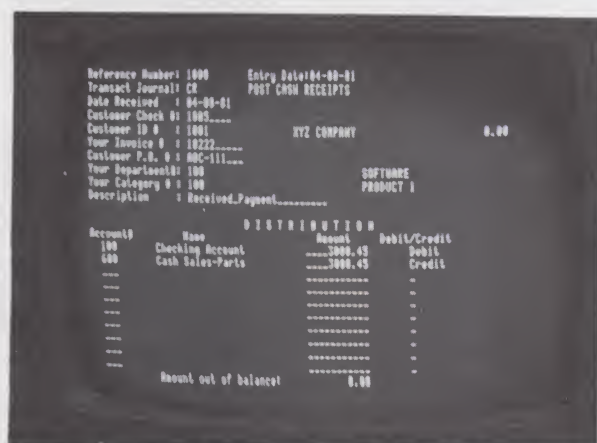
Task scheduler—The program segment within a multitask operating system that provides for the orderly interruption of the current task, the saving of its context (register contents) and the activation of the following task.

Time slice—The increment of time during which each task is allowed to run. Time slices are short enough that each user appears to have full use of the computer all the time.

Virtual storage (also virtual memory)—The operating system technique that permits programs or data to exceed the physical size of main memory. Program or data segments are swapped from disk to memory as needed, with the swapping being invisible to the users, who need not be concerned with the physical size of memory.

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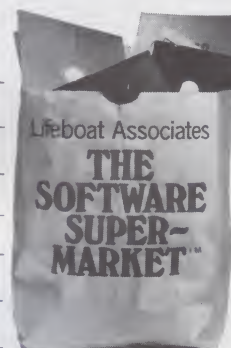
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Microcomputing, June 1981 37

tems. To get a feel for the good and bad points of each of these approaches, let's look at two examples of multi-user microcomputers currently available. The first is a multi-task system; the second a multiprocessor.

These two examples have been chosen because they are both fairly new systems, are very affordable, and have been designed from the ground up for multi-users. They are not just adaptations of older hardware and software. One result of starting with a clean slate is that there are no constraints on the designers of either the hardware or software, and the resulting product should be the best possible solution to the multi-user problem.

Either system obviously can be operated as a single-user computer, but their true value comes to light when a second work station is attached. In this two-terminal configuration, either system can be purchased for under \$10,000, including software. Adding more work stations to the multiprocessor will cost more than similar additions to the multitask system, as each user needs his own CPU

and memory as well as a terminal. Other cost and convenience trade-offs will be discussed later.

IBC System 40

The System 40 from Integrated Business Computers (22010 S. Wilmington Ave., Carson, CA 90745) is truly integrated, in that the complete computer with a Z-80A microprocessor running at 4 MHz, 128K of RAM, six serial I/O ports and both floppy disk and Winchester hard-disk controllers are all included on a single 15-inch-square printed circuit (PC) board. This board is mounted along with power supplies and two double-sided dual-density floppy-disk drives in a seven-inch-high rack-mountable enclosure. Simply plug any combination of CRT terminals and printers into the six RS-232 connectors on the rear of the computer and you're in business.

The base system price includes 64K of RAM, the pedestal enclosure shown under the printer in the photograph, and a choice of one operating system: either MVT FAMOS or OASIS from Phase One. Both operating systems include the usual array of ed-

The Sources

IBC/Integrated Business Computers
22010 S. Wilmington Avenue
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213-518-4245

Action Computer Enterprise, Inc.
55 W. Del Mar Blvd.
Pasadena, CA 91105
213-793-2440

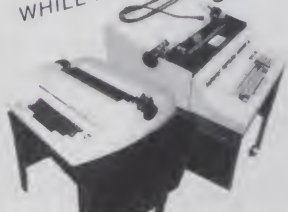
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itor, assembler, debugger and file handling programs. Both also support their own versions of BASIC and word processing programs. Other languages, including FORTRAN, CO-

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BOL and Pascal, are either available or are being developed, so the potential purchaser should check with IBC to determine current availabilities and prices.

The IBC computer has hardware features designed to increase reliability and reduce servicing costs. With all the circuitry on a single board, inexperienced service people could easily provide field repairs. If a quick check of power supply voltages shows all present, the trouble is isolated to either the single board or the disk drives, and a quick swap can be made.

Reliability is enhanced because the System 40 includes a minimum of connectors. Peripherals attach to the PC board with ribbon cables, and there is no motherboard or back plane with a multitude of card edge connectors. Total circuitry is minimized as well, as no ICs are needed to implement an expandable bus structure. An additional benefit is reduced power consumption.

The disadvantage of this busless approach is that there is no provision for adding peripherals other than those supported by the basic ma-

chine. If some other device proves to be an absolute necessity, one of the six RS-232 ports will have to be dedicated to this use. Peripherals currently available from other vendors, which can be connected through an RS-232 port, include battery operated calendar clocks, modems, analog-to-digital converters, industrial controllers and even PROM programmers.

With only six ports available for user terminals, printers and these other options, expandability is limited. But in the business environment for which the IBC System 40 was designed, the lack of an expansion bus should prove no problem.

The Discovery from ACE

Action Computer Enterprise, Inc., produces the Discovery Multiprocessor, also Z-80A-based, but with a separate processor for each user. The Discovery provides a friendly environment for present microcomputer users, as it is compatible with S-100 bus hardware and CP/M software.

Each user terminal connects via an RS-232 interface to its own Z-80A CPU with 64K of RAM. One additional processor controls the S-100

bus and provides access to floppy- and hard-disk drives. This service processor can also provide access to any other S-100-compatible peripheral, with the only constraint being that all plug-in controllers have to be I/O-mapped devices, rather than memory-mapped. A user of an existing S-100-based system can therefore salvage a lot of hardware, and plug it into the Discovery.

Learning a new operating system will not be necessary for current users of CP/M. Discovery's service processor runs the Distributed Processing Operating System (DPOS), which will load any user processor with any version of CP/M. To demonstrate the flexibility of this multiprocessor, two users have simultaneously run two different versions (1.4 and 2.2) of CP/M, sharing disk accesses on both floppy- and hard-disk drives.

It is this familiar hardware and software environment that is Discovery's strong point. All CP/M-compatible software can run on the system, and since each user has his own 64K memory space, there is no need for relocatable programs. Discovery can even be comfortably used for assem-

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bly-language, or even machine-language, program development and debugging, as the service processor and DPOS ensure that each user runs without interfering with his neighbors.

Each user even has his own hardware reset switch, in case he gets into an infinite loop, or executes a HALT instruction. And yet each user can still safely access all of the common resources, such as the disks, printers and any other S-100-compatible peripheral plugged into Discovery's 22-slot mainframe. These accesses will have to be made through driver programs installed on the service processor, since user CPUs do not have access to the S-100 bus except through service calls. This provides the hardware and software protection for the other users.

Since the service processor handles all the heavy peripheral tasks, the us-

er CPUs are not burdened with any extra software overhead. Since the resident portion of CP/M takes up only 6K bytes, the user has access to all the rest of his 64K memory space. With the service processor providing features such as print spooling, the user memory space is not burdened with any extra software overhead.

The Discovery can be supplied in a bare-bones configuration, in case the purchaser already owns compatible disk drives, controllers, terminals or printers. This provides a minimum cost upgrade from an existing S-100 based single-user system. And following such an upgrade, all existing CP/M software will be instantly usable on Discovery.

Features Common to Both Computers

A number of features of multi-user systems are included in both comput-

ers. Perhaps the most important is in the protection of data files. Since either system will support terminals in different rooms, it is necessary, for example, to prevent the shop foreman from gaining access to the accountant's data and programs.

Users on either computer can specify various levels of access protection for their program and data files. A file can be made available to all other users for read or write, or it can be made read-only, or it can be fully protected, with only the authorized user even knowing it exists.

Another handy feature is print spooling, permitting a user to request the printing of data while he goes ahead with the next job. Since printers are the slowest peripherals on a computer, a system would not be very efficient if it tied up a CPU full-time just to output data to a printer. In the IBC system, printing is just another task handled by the scheduler. In the ACE computer it is a program resident in the service processor.

Winchester hard-disk subsystems are now available for little more than a floppy-disk system cost just five years ago. Floppies have since increased in storage capacity and have dropped in price, but even with the increased storage a floppy-based computer will soon run out of mass storage space as more and more users are added. To support the inevitable, ACE and IBC both supply hard-disk add-ons, with similar (but not identical) capacities and prices.

The IBC System 40 is typically configured with four CRT terminals and two printers on its six serial ports, while the ACE Discovery can have six user processors, and one printer connected to the service processor. Both companies plan expansion to more users at a later date.

Conclusions

The IBC System 40 provides more capability with fewer components, thanks to the single board construction. Reliability, ease of maintenance and low power consumption result. On the negative side, the multitask operating systems exact a heavy toll, requiring from 32K to 48K of memory for the MTOS alone. This means that each user can have less memory allocated to him at any one time, requiring more frequent disk accesses. With only a single Z-80A to service four CRT terminals, two printers, and both floppy- and hard-disk systems, it is inevitable that some tasks

The IBC Ensign Multi-user

IBC/Integrated Business Computers has recently introduced a powerful Z-80-based computer to its multi-user line. The Ensign computer offers an upgrade path to both dealers and end users who need a larger, more powerful system yet want to keep their library of Z-80-based software intact.

Features include:

- Ability to support up to 16 CRT/printers.
- 64K to 768K byte memory, bank selectable at any size from 4K to 64K/bank.
- 6 MHz Z-80B CPU.
- 14, 42, 70 and 150 megabyte Winchester disk drives.
- Both 17 megabyte tape cartridge and nine-track reel-to-reel tape drive.
- Slave twin Z-80s to handle all serial I/O with 2K byte buffer/serial I/O port (32K byte total). Slave Z-80s prevent high serial I/O usage from degrading main CPU throughput.
- A third slave Z-80 to handle all disk/tape I/O and an advanced DMA controller that allows data transfer to any memory whether selected by main CPU or not. This allows very heavy disk I/O without degrading main CPU throughput.

All of these features are on IBC's new segmented single board com-

puter (SSBC), which allows memory and disk speeds not attainable on an S-100 bus.

Software supported by the IBC Ensign includes MP/M, CP/M, Oasis and MVT-FAMOS. These operating systems represent the vast majority of Z-80-based software. With the Ensign, IBC introduces its new operating system: Superdos.

Supporting Business Basic and COBOL, Superdos combines with the Ensign to give minicomputer performance. Even when supporting 16 users under a heavy load, response for ISAM lookup on very large files will be under one second. Also, there is plenty of very good applications software running right now on expensive minicomputers supporting Business Basic and COBOL.

Up until now a computer dealer or end user had to rewrite all his software for a more expensive minicomputer if he wanted a larger system. With the Ensign all the software can be run unchanged with vastly improved performance.

The cost of the 64K byte Ensign with eight serial I/O ports and 2 megabytes of disk is \$7000. The cost of expanded Ensign with 16 serial I/O ports, 768K memory, 70 megabyte disk and tape drive is approximately \$33,000.

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will have to be slowed down at some time or other. On the brighter side, slow responses will be noticed most often at "logical" times, as when requesting a new program or more data from the disk.

The least desirable feature of the Integrated Business Computers system is its lack of compatibility with existing application software, such as accounting packages and word processors like WordStar and Spellbinder. The suppliers of software to IBC have such programs available, but the purchaser does not have the wide range of choice that users of more common operating systems do. Application programs are seldom available in source format, which would permit their easy adaptation to the System 40. But if the user is happy with the software offerings available, he has the advantage of knowing that all his programs come from a single supplier, which should eliminate conflicts and support problems.

Compatibility in hardware and software is the strong point of the Discovery Multiprocessor from Action Computer Enterprise. If you are familiar with the microcomputer

scene, you know what S-100 and CP/M compatibility can mean in terms of the software availability and special-purpose peripherals.

Of course, in an industry with so many suppliers there are some bad eggs, and "compatible" sometimes does not mean just plug it in and go. But with some care in product selection, there is a virtually unlimited array of hardware and software products on the market that can run on the Discovery. And all can run at full speed at the same time.

With a Z-80A running at 4 MHz for each user, plus another for servicing peripherals, there should never be any waiting with this computer. In addition to never having to share his CPU, each Discovery user has access to the maximum memory space available in the Z-80 microprocessor.

In addition, the Discovery can be used in environments that would be inconvenient or impossible for the System 40. These include multi-user hardware development systems and industrial controllers where much special interfacing is required.

While the Discovery contains many more connectors and ICs than

the IBC computer, reliability is not necessarily a problem. Since each user has identical hardware, the failure of a single component, say one of the Z-80s, would not mean that the entire system is inoperable. Performance can be degraded in the ACE computer by the loss of a single component, whereas the IBC machine could become totally inoperable.

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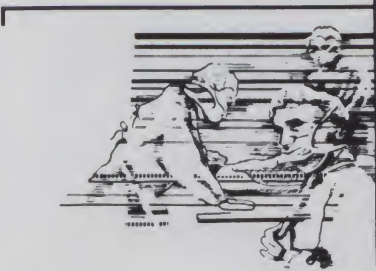
Both of these computers have strong points and some weaknesses. For general business data processing, there can be no clear-cut decision between the two. The potential purchaser will find no shining features or glaring deficiencies on which to base a choice between these two. Since the System 40 was designed to be a business computer, it is not "deficient" in its lack of a similar level of compatibility and expandability, which are the best features of the Discovery.

With a choice between two multi-user microcomputers with price tags of less than \$10,000 including software and two terminals, it looks like the potential purchaser is the big winner. ■

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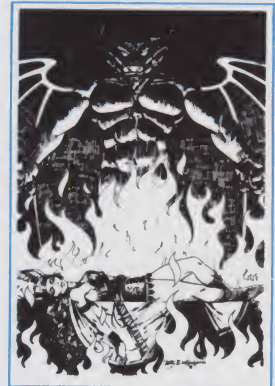
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North Star Quiz

By Rinaldo F. Prisco

Here is a short quiz for North Star BASIC users:

1. What is the starting address of the programs in RAM?
2. What do the first three bytes of a

program in RAM signify?

3. What is the end-of-program flag?
4. What is the format for coding

line numbers referenced within a

program?

5. How is the end of a programming line indicated?
6. When a new line is added to a

program, is it placed at the end of the program or is it placed in sequential order, moving the other lines if necessary?

7. If a program is saved on disk, what do the first three bytes in the file signify?
8. Is it possible to open a BASIC

program file from another BASIC program which treats it as a data file?

9. State precisely how the line:

120 IF A>B THEN 220

will be coded in hex.

10. "!" and "PRINT" signify the same thing. How many additional bytes of program space are required for each replacement of "!" by "PRINT"?

If you can answer at least seven of the above questions (even using references) in less than 20 minutes, skip this article. On the other hand, if you

STRING	DECIMAL	HEX	STRING	DECIMAL	HEX
!	146	92	INCHAR\$	186	BA
(	224	E0	INP	217	D9
*	226	E2	INPUT	134	86
+	227	E3	LEN	204	CC
-	229	E5	LET	128	80
/	231	E7	LINE	156	9C
<	244	F4	LIST	161	A1
<=	240	F0	LOAD	165	A5
<>	241	F1	LOG	221	DD
=	245	F5	MEMSET	162	A2
>	246	F6	NEXT	131	83
>=	239	EF	NOENDMARK	185	B9
ABS	219	DB	NOT	247	F7
AND	236	EC	NSAVE	169	A9
ASC	182	B6	ON	147	93
ATN	210	D2	OPEN	151	97
AUTO	164	A4	OR	237	ED
CALL	205	CD	OUT	148	94
CAT	175	AF	PRINT	130	82
CHAIN	155	9B	PSIZE	174	AE
CHR\$	181	B5	READ	133	85
CLOSE	152	98	REM	143	8F
CONT	166	A6	REN	168	A8
COS	220	DC	RESTORE	142	8E
CREATE	158	9E	RETURN	138	8A
DATA	135	87	RND	206	CE
DEF	145	91	RUN	160	A0
DEL	173	AD	SAVE	170	AA
DESTROY	157	9D	SCR	163	A3
DIM	139	8B	SIN	203	CB
ELSE	180	B4	SQRT	196	C4
END	141	8D	STEP	176	B0
ERRSET	159	9F	STOP	140	8C
EXAM	218	DA	STR\$	184	B8
EXIT	150	96	TAB	179	B3
EXP	222	DE	THEN	178	B2
FILL	149	95	TO	177	B1
FN	144	90	TYP	223	DF
FOR	129	81	VAL	183	B7
GOSUB	137	89	WRITE	153	99
GOTO	136	88	^	225	E1
IF	132	84			

Table 1. North Star strings and codes.

```

0 REM REPLACE "!" BY "PRINT"
1 A=23612:E=146:P=130:G=154:C=13
2 A=A+1:IF EXAM(A)=1 THEN END
3 A=A+2
4 A=A+1:B=EXAM(A)
5 IF B=C THEN 2
6 IF B=G THEN 3
7 IF B=E THEN FILL A,P:GOTO 4

```

Listing 1. Replaces each occurrence of "!" by "PRINT" in any appended program.

Dr. Rinaldo F. Prisco (RD #7, Box 80, Oswego, NY 13126) is an Associate Professor of Mathematics for the State University of New York, College at Oswego.


```

0000          0010 * REPLACE "!" BY "PRINT"
0000          0020 * IN A PROGRAM IN BASIC
0000          0030 *
0000 21 92 5B          0040          LXI  H,5B92H
0003 06 01          0050          MVI  B,1          END PROG FLAG
0005 0E 92          0060          MVI  C,146          "!" CODE
0007 16 82          0070          MVI  D,130          "PRINT" CODE
0009 1E 9A          0080          MVI  E,154          "GOTO" FLAG
000B 23          0090 ST          INX  H
000C 7E          0100          MOV  A,M
000D B8          0110          CMP  B
000E C8          0120          RZ
000F 23          0130 ST2          INX  H          SKIP LINE #'S
0010 23          0140          INX  H
0011 23          0150 ST3          INX  H
0012 7E          0160          MOV  A,M
0013 FE 0D          0170          CPI  13          END OF LINE?
0015 CA 0B 00          0180          JZ   ST
0018 BB          0190          CMP  E          A "GOTO"?
0019 CA 0F 00          0200          JZ   ST2
001C B9          0210          CMP  C          A "!"?
001D C2 11 00          0220          JNZ  ST3
0020 72          0230          MOV  M,D          REPLACE BY "PRINT"
0021 C3 11 00          0240          JMP  ST3

SYMBOL TABLE
ST      000B      ST2    000F      ST3    0011

```

Listing 2. Replaces each occurrence of "!" by "PRINT" in any loaded BASIC program.

are curious about the answers and about how the answers might benefit you, then read on.

Codes

To conserve space and increase the execution speed, certain key strings in North Star BASIC are hashed into single-byte codes. Table 1 presents the sorted strings with corresponding codes in both decimal and hex. Table 2 provides the same information, but sorted by codes. Reference to these codes will help in reading or modifying a BASIC program in RAM.

Some applications which a knowledge of the coding conventions allows include recovery of most of a program that has been prematurely scratched, program sizes down to the precise byte, appending programs from RAM, variable and statement maps, program compactification, program locks, self-modifying programs and almost instantaneous changes of variables and statements.

The list can go on and on. Because of space limitations only a few of these applications will be discussed below. They are fairly straightforward programming procedures which rely on a knowledge of the code tables and many of the answers to the above quiz.

Simple Replacement

The tables indicate that the decimal codes for "!" and "PRINT" are 146 and 130, respectively. Thus, the answer to question 10 is that no additional bytes are required. So if we want to make our programs more

readable to users of other BASICs, we can use "PRINT" in place of "!" without any additional space over-

head. In fact, we don't even have to have the additional overhead of entering five characters in place of one.

If any BASIC program is appended to that in Listing 1 and then run, the replacement will be done throughout the program (except where "!" appears within quotes). A much faster assembly-language program which does the same thing appears in Listing 2.

The design of such programs requires the answers to the first four quiz questions. You must know where to begin your search (question 1), how to ignore bytes which reference line numbers (questions 2 and 4) and when to stop (question 3). The program area in Release 4 begins at 23443. The first byte in a line contains the number of bytes in that line; the next two bytes contain the line number. Line numbers referenced with a line (such as for GOTO, THEN, EXIT, GOSUB) are always prefaced by byte 154. The end of a line is indicated by 13, which is the

DECIMAL	HEX	STRING	DECIMAL	HEX	STRING
128	80	LET	174	AE	PSIZE
129	81	FOR	175	AF	CAT
130	82	PRINT	176	B0	STEP
131	83	NEXT	177	B1	TO
132	84	IF	178	B2	THEN
133	85	READ	179	B3	TAB
134	86	INPUT	180	B4	ELSE
135	87	DATA	181	B5	CHR\$
136	88	GOTO	182	B6	ASC
137	89	GOSUB	183	B7	VAL
138	8A	RETURN	184	B8	STR\$
139	8B	DIM	185	B9	NOENDMARK
140	8C	STOP	186	BA	INCHAR\$
141	8D	END	196	C4	SQRT
142	8E	RESTORE	203	CB	SIN
143	8F	REM	204	CC	LEN
144	90	FN	205	CD	CALL
145	91	DEF	206	CE	RND
146	92	!	210	D2	ATN
147	93	ON	217	D9	INP
148	94	OUT	218	DA	EXAM
149	95	FILL	219	DB	ABS
150	96	EXIT	220	DC	COS
151	97	OPEN	221	DD	LOG
152	98	CLOSE	222	DE	EXP
153	99	WRITE	223	DF	TYP
155	9B	CHAIN	224	E0	(
156	9C	LINE	225	E1	^
157	9D	DESTROY	226	E2	*
158	9E	CREATE	227	E3	+
159	9F	ERRSET	229	E5	-
160	A0	RUN	231	E7	/
161	A1	LIST	236	EC	AND
162	A2	MEMSET	237	ED	OR
163	A3	SCR	239	EF	>=
164	A4	AUTO	240	F0	<=
165	A5	LOAD	241	F1	<>
166	A6	CONT	244	F4	<
168	A8	REN	245	F5	=
169	A9	NSAVE	246	F6	>
170	AA	SAVE	247	F7	NOT
173	AD	DEL			

Table 2. North Star codes and strings.

ASCII for CR.

You could, of course, modify the programs in Listing 1 and 2 for any replacements whatsoever. Poor typists could type in single-letter codes of their own for key codes and later run a program to make the replacement. If the key codes are permuted, then a BASIC program becomes incomprehensible unless one can decode it, giving some degree of privacy.

Complex Analysis

The replacement program is short enough so that it can work directly on a target program RAM. More com-

plex modification or analysis of programs may require a good deal of space. What do you do if you have a large modification or analysis program, a large target program and limited RAM? Here is where the answer to quiz question 8 is needed. Indeed, the answer is yes! So you can access the target program as a data file, modify it and, if necessary, rewrite it to another file.

You can also extract information about the target program. The technique is to use READs instead of EX-AMs, and WRITEs instead of FILLs. The GOTO program in Listing 3 uses

this technique to get a table of all referenced line numbers in a target program, indicating the type of reference used (GOTO, GOSUB or EXIT).

The key bit of information which made this program easy to design was that all such line number references specify the line number by the two bytes which follow byte 154. So all you have to do is keep track of the source line number being scanned S(K) and look for byte 154. If found, you then record the referenced line in T(K) and backtrack (decrease pointer P) to see which type of statement made the reference: THEN (178), ELSE (180), GOTO (136), EXIT (150) or GOSUB (137).

The first three of them are variations of GOTO and are indicated in the printout in the same way. While EXIT is also a variation of GOTO, it is treated as a special case. Line 320 of the GOTO program codes the three cases: 1 for GOTO, ELSE or THEN; 2 for GOSUB; 3 for EXIT. These codes are then appended to the source line S(K).

On completion of the program scan, the target line numbers T(K) are sorted and the program passes to a simple printing routine for the formatted table.

Table 3 is the result of running the GOTO program on the dummy test program in Listing 4. Note that line 3 of the table verifies that line 250 of the dummy program is the target of lines 300, 700 and 800 with GOTOs, line 120 with GOSUB and line 190 with EXIT.

Concluding Remarks

We have discussed the codes and coding procedures used for North Star BASIC. These coding conventions were applied to the design of a simple replacement program and a more complex program which tabulates program flow.

An indication of the almost unlimited number of possible applications was also discussed. Although good

```
100 REM          EXTENDED GOTO
110 REM
120 REM          AUG. 1, 1980
130 REM
140 REM          RINALDO F. PRISCO
150 REM          MATHEMATICS DEPT.
160 REM          SUNY, COLLEGE AT OSWEGO
170 REM          OSWEGO, NY 13126
180 REM
190 DIM S(200),T(200)
200 K=1:G=154: REM - Line #'s prefaced by 154
210 INPUT "ENTER NAME OF BASIC PROGRAM: ",B$
220 OPEN #0%2,B$
230 READ #0,&L:P=P+1:IF L=1 THEN 340
240 READ #0,&D1,&D2:N=D1+256*D2:REM LINE #
250 P=P+2
260 READ #0,&C:P=P+1:IF C=13 THEN 230
270 IF C<>G THEN 260
280 READ #0,&D1,&D2:P=P+2:M=D1+256*D2
290 F=P-2

300 F=F-1:READ #0%F,&C
310 IFNOT (C=178ORC=136ORC=137ORC=150ORC=180) THEN300
320 C=1+(C=137)+2*(C=150)
330 T(K)=M:S(K)=N+C/10:K=K+1:READ #0%P,&C:GOTO 260
340 REM SORT
350 K=K-1:M=K
360 M=INT(M/2):IF M=0 THEN 450
370 J=1:N=K-M
380 I=J
390 L=I+M

400 IF T(I)<T(L) THEN 440
405 IF T(I)=T(L) THEN IF S(I)<=S(L) THEN 440
410 S=S(I):S(I)=S(L):S(L)=S
420 T=T(I):T(I)=T(L):T(L)=T
430 I=I-M:IF I>0 THEN 390
440 J=J+1:IF J>N THEN 360 ELSE 380
450 REM PRINT ROUTINE
460 INPUT "HARD COPY? ",Y$
470 IF Y$(1,1)="Y" THEN FILL 51207,2
480 !B$,""S GOTOs":!;!
490 K=1
500 X=1:T=T(K):!
510 IF T=0 THEN 590
520 !%8I,T," <==",
530 !S(K)," ",
540 K=K+1:X=X+1
550 IF T<>T(K) THEN 500
560 IF X<8 THEN 580
570 !:!TAB(15),:X=0
580 !S(K)," ",:GOTO 540
590 FILL 51207,0:END
```

Listing 3. Provides an extensive GOTO map of any BASIC program on disk.

```
180 <== 190.1
220 <== 200.1    900.1
250 <== 120.2    190.3    300.1    700.1    800.1
530 <== 120.1    700.2
600 <== 300.1    500.3    900.1
```

Table 3. The GOTO table for the dummy test program in Listing 4.

```
100 REM DUMMY TEST PROGRAM
120 GOSUB 250:GOTO 530
190 GOTO 180: EXIT 250
200 GOTO 220
300 GOTO 600:GOTO 250
500 EXIT 600
700 GOTO 250:GOSUB 530
800 GOTO 250
900 IF A>B THEN 220 ELSE 600
```

Listing 4. A test program for Listing 3.



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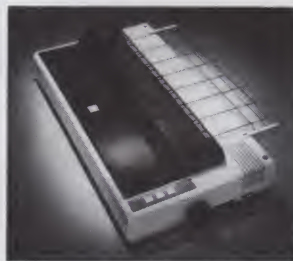
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commercial software for the modification and analysis of North Star BASIC programs is available, no software can anticipate all possible needs of its users. There is just no substitute for know-how. ■

Quiz Answers

1. For Release 4, the first program byte is addressed at 23443 (5B93H).
2. The first byte is the number of bytes in the first program line; the next two bytes comprise its line number (in the 8080 format of low byte, high byte).
3. Program endings are indicated by the ASCII code SOH (byte 01).
4. All such references consist of two bytes as in (2) above; these bytes are flagged by byte 154 (9AH).
5. Program line endings are indicated by the ASCII code for CR, 13.
6. It is placed in its proper sequential order.
7. The same thing as they do in RAM; see the answer to (2) above.
8. Yes, use the North Star convention of specifying the file type (2 in this case) when OPENing it.
9. 10 78 00 20 84 20 41 F6 42 20 B2 20 9A C8 00 0D
10. None; they both use one byte.

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0-6-KM

Plan Your Retirement On Easy Street

By G. R. Brieger

Death and taxes are two inescapable facts of life. We are faced today with a third—inflation. Thus, financial planning for retirement—though difficult and involved—is more important than ever.

VisiCalc software can help. It is ideal for solving "what if" problems. And while the application described

here is for an Apple II+, VisiCalc is also available for the TRS-80, Commodore, Hewlett-Packard, Atari and PET microcomputers.

What Is VisiCalc?

VisiCalc is unique. Its manufacturer says that it is merely an electronic calculation sheet, but VisiCalc does a

lot more. It could be called a limited enclosed computer language.

The program comprises 254 horizontal rows and 63 vertical columns for calculations. It provides over 16,000 locations for values, formulas

Address correspondence to G. R. Brieger, 2716 174th NE, Redmond, WA 98052.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
YEAR	SS	HUSB.	SS WIFE	S.S.H+W	SPEND/	I.R.A.	WITHDRAW	LIQU. ASS.	TAXABLE	TAXES/	ASS. BEG.%	OF 1980	VALUE IN	GRAPHIC DISPLAY
			% INCREASE	/MONTH MONTH	%	AT %	FROM IRA	AT %	INCOME	YEAR	OF YEAR	DOLLARS	1980 \$'S	OF ASSETS FROM
														COLUMN "Y"
6	1980	6.00	6.00		1500	100000		100000	11000	530	200000	100	1500	*****
7	1981				1590	106000	5000	92470	15172	1200	198470	100	1590	*****
8	1982				1685	112660	5000	87362	14610	1050	200022	100	1685	*****
9	1983	560		560	1787	118053	7000	80697	15877	1200	198749	100	1787	*****
10	1984	594		594	1894	122038	9000	80655	17872	1600	202693	100	1894	*****
11	1985	629	315	944	2007	123463	12000	81326	20946	2200	204788	100	2007	*****
12	1986	667	333	1000	2128	123043	14000	87309	23604	2900	210353	100	2128	*****
13	1987	707	353	1060	2255	121578	15000	94485	25393	3400	216064	100	2255	*****
14	1988	749	375	1124	2391	117952	17000	102139	28235	4200	220091	100	2391	*****
15	1989	794	397	1192	2534	110927	20000	110975	32207	5300	221901	100	2534	*****
16	1990	842	421	1263	2686	103129	20000	121770	33395	5600	224898	100	2686	*****
17	1991	893	446	1339	3271	101082	13390	121770	26785	3600	222852	115	2847	*****
18	1992	946	473	1419	3351	98811	13390	121770	26785	3600	220581	111	3018	*****
19	1993	1003	501	1504	3436	96290	13390	121770	26785	3600	218060	107	3199	*****
20	1994	1063	532	1595	3527	93492	13390	121770	26785	3600	215262	104	3391	*****
21	1995	1127	563	1690	3622	90385	13390	121770	26785	3600	212155	101	3595	*****
22	1996	1194	597	1792	3724	86938	13390	121770	26785	3600	208707	98	3811	*****
23	1997	1266	633	1899	3831	83110	13390	121770	26785	3600	204890	95	4039	*****
24	1998	1342	671	2013	3945	78862	13390	121770	26785	3600	200632	92	4282	*****
25	1999	1423	711	2134	4066	74147	13390	121770	26785	3600	195917	90	4538	*****
26	2000	1508	754	2262	4194	68913	13390	121770	26785	3600	190683	87	4811	*****
27	2001	1598	799	2398	4330	63103	13390	121770	26785	3600	184873	85	5099	*****
28	2002	1694	847	2542	4474	56654	13390	121770	26785	3600	178424	83	5405	*****
29	2003	1796	898	2694	4626	49495	13390	121770	26785	3600	171265	81	5730	*****
30	2004	1904	952	2856	4788	41549	13390	121770	26785	3600	163319	79	6073	*****
31	2005	2018	1009	3027	4959	32730	13390	121770	26785	3600	154500	77	6438	*****
32	2006	2139	1070	3209	5141	22940	13390	121770	26785	3600	144709	75	6824	*****
33	2007	2267	1134	3401	5333	12073	13390	121770	26785	3600	133843	74	7234	*****
34	2008	2403	1202	3605	5537	10	13390	121770	26785	3600	121780	72	7668	*****
35	2009	2548	1274	3821	4867	6	5	121770	13400	850	121776	60	8128	*****
36	2010	2701	1350	4051	5096		0	121770	13395	850	121770	59	8615	*****
37								TOTAL INC. TAX	95680					

Table 1. Sample retirement table. Tables 2-4 show results using different variables.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
YEAR	SS HUSB.	SS WIFE	S.S.H+W	SPEND/	I.R.A.	WITHDRAW	LIQU.ASS.	TAXABLE	TAXES/	ASS. BEG. %	OF 1980	VALUE IN	GRAPHIC DISPLAY	OF ASSETS FROM	
	% INCREASE		/MONTH	MONTH	AT %	FROM IRA	AT %	INCOME	YEAR	OF YEAR	DOLLARS	1980 \$'S	COLUMN "K"		
6	1980	5.00	5.00		5	11.00	11.00	11000	530	200000	100	1500	*****	*****	
7	1981				1575	106000	5000	92470	1200	198470	100	1575	*****	*****	
8	1982				1654	112660	5000	87542	14630	200202	100	1654	*****	*****	
9	1983	560		560	1736	118053	7000	81276	15940	199329	100	1736	*****	*****	
10	1984	588		588	1823	122038	9000	81899	18009	203938	100	1823	*****	*****	
11	1985	617	309	926	1914	123463	12000	83285	21161	2400	206748	100	1914	*****	*****
12	1986	648	324	972	2010	123043	14000	90187	23921	2900	213230	100	2010	*****	*****
13	1987	681	340	1021	2111	121578	15000	98754	25863	3400	220333	100	2111	*****	*****
14	1988	715	357	1072	2216	117952	17000	108142	28896	4200	226094	100	2216	*****	*****
15	1989	750	375	1126	2327	110927	20000	119108	33102	5600	230035	100	2327	*****	*****
16	1990	788	394	1182	2443	103129	20000	132194	34541	6000	235323	100	2443	*****	*****
17	1991	827	414	1241	3244	101083	13390	132194	27931	3900	233277	126	2566	*****	*****
18	1992	869	434	1303	3306	98812	13390	132194	27931	3900	231006	123	2694	*****	*****
19	1993	912	456	1368	3371	96291	13390	132194	27931	3900	228485	119	2828	*****	*****
20	1994	958	479	1437	3439	93493	13390	132194	27931	3900	225687	116	2970	*****	*****
21	1995	1006	503	1509	3511	90387	13390	132194	27931	3900	222582	113	3118	*****	*****
22	1996	1056	528	1584	3587	86940	13390	132194	27931	3900	219134	110	3274	*****	*****
23	1997	1109	554	1663	3666	83113	13390	132194	27931	3900	215308	107	3438	*****	*****
24	1998	1164	582	1746	3749	78866	13390	132194	27931	3900	211060	104	3610	*****	*****
25	1999	1222	611	1834	3836	74151	13390	132194	27931	3900	206345	101	3790	*****	*****
26	2000	1284	642	1925	3928	68918	13390	132194	27931	3900	201112	99	3980	*****	*****
27	2001	1348	674	2022	4024	63109	13390	132194	27931	3900	195303	96	4179	*****	*****
28	2002	1415	708	2123	4125	56660	13390	132194	27931	3900	188855	94	4388	*****	*****
29	2003	1486	743	2229	4231	49503	13390	132194	27931	3900	181698	92	4607	*****	*****
30	2004	1560	780	2340	4343	41558	13390	132194	27931	3900	173753	90	4838	*****	*****
31	2005	1638	819	2457	4460	32740	13390	132194	27931	3900	164934	88	5080	*****	*****
32	2006	1720	860	2580	4583	22951	13390	132194	27931	3900	155146	86	5334	*****	*****
33	2007	1806	903	2709	4712	12086	13390	132194	27931	3900	144280	84	5600	*****	*****
34	2008	1896	948	2845	4847	25	13390	132194	27931	3900	132220	82	5880	*****	*****
35	2009	1991	996	2987	4112	21	7	132194	14548	1050	132216	67	6174	*****	*****
36	2010	2091	1045	3136	4260		0	132194	14541	1050	132194	66	6483	*****	*****
37								TOTAL INC. TAX	102580						

Table 2.

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O			
YEAR	SS HUSB.	SS WIFE	S.S.H+W	SPEND/	I.R.A.	WITHDRAW	LIQU.ASS.	TAXABLE	TAXES/	ASS. BEG.%	OF 1980	VALUE IN	GRAPHIC DISPLAY	OF ASSETS FROM			
	% INCREASE		/MONTH	MONTH	AT %	FROM IRA	AT %	INCOME	YEAR	OF YEAR	DOLLARS	1980 \$'S	COLUMN "K"				
6	1980	5.00	5.00		1600	100000		11.00	11.00	100000	11000	530	200000	100	1600	*****	*****
7	1981				1680	106000	5000	91270	15040	1200	197270	100	1680	*****	*****	*****	*****
8	1982				1764	112660	5000	84950	14344	1050	197610	100	1764	*****	*****	*****	*****
9	1983	560		560	1852	118053	7000	77076	15478	1200	195129	100	1852	*****	*****	*****	*****
10	1984	588		588	1945	122038	9000	75848	17343	1600	197887	100	1945	*****	*****	*****	*****
11	1985	617	309	926	2042	123463	12000	75310	20284	2200	198772	100	2042	*****	*****	*****	*****
12	1986	648	324	972	2144	123043	14000	80002	22800	2700	203046	100	2144	*****	*****	*****	*****
13	1987	681	340	1021	2251	121578	15000	86042	24465	3000	207620	100	2251	*****	*****	*****	*****
14	1988	715	357	1072	2364	117952	17000	92742	27202	3900	210694	100	2364	*****	*****	*****	*****
15	1989	750	375	1126	2482	110927	20000	100542	31060	5000	211468	100	2482	*****	*****	*****	*****
16	1990	788	394	1182	2606	103129	20000	110324	32136	5300	213452	100	2606	*****	*****	*****	*****
17	1991	827	414	1241	3085	101082	13390	110324	25526	3400	211406	113	2737	*****	*****	*****	*****
18	1992	869	434	1303	3147	98811	13390	110324	25526	3400	209135	110	2873	*****	*****	*****	*****
19	1993	912	456	1368	3212	96290	13390	110324	25526	3400	206614	106	3017	*****	*****	*****	*****
20	1994	958	479	1437	3281	93491	13390	110324	25526	3400	203815	104	3168	*****	*****	*****	*****
21	1995	1006	503	1509	3352	90385	13390	110324	25526	3400	200709	101	3324	*****	*****	*****	*****
22	1996	1056	528	1584	3428	86937	13390	110324	25526	3400	197261	98	3497	*****	*****	*****	*****
23	1997	1109	554	1663	3507	83109	13390	110324	25526	3400	193433	96	3667	*****	*****	*****	*****
24	1998	1164	582	1746	3590	78861	13390	110324	25526	3400	189185	93	3851	*****	*****	*****	*****
25	1999	1222	611	1834	3677	74145	13390	110324	25526	3400	184469	91	4043	*****	*****	*****	*****
26	2000	1284	642	1925	3769	68911	13390	110324	25526	3400	179235	89	4245	*****	*****	*****	*****
27	2001	1348	674	2022	3865	63101	13390	110324	25526	3400	173425	87	4458	*****	*****	*****	*****
28	2002	1415	708	2123	3966	56651	13390	110324	25526	3400	166975	85	4680	*****	*****	*****	*****
29	2003	1486	743	2229	4073	49493	13390	110324	25526	3400	159817	83	4914	*****	*****	*****	*****
30	2004	1560	780	2340	4184	41546	13390	110324	25526	3400	151870	81	5160	*****	*****	*****	*****
31	2005	1638	819	2457	4301	32726	13390	110324	25526	3400	143050	79	5418	*****	*****	*****	*****
32	2006	1720	860	2580	4424	22936	13390	110324	25526	3400	133260	78	5689	*****	*****	*****	*****
33	2007	1806	903	2709	4553	12068	13390	110324	25526	3400	122392	76	5974	*****	*****	*****	*****
34	2008	1896	948	2845	4688	5	13390	110324	25526	3400	110329	75	6272	*****	*****	*****	*****
35	2009	1991	996	2987	3940	1	5	110324	12141	700	110325	60	6586	*****	*****	*****	*****
36	2010	2091	1045	3136	4089		0	110324	12136	700	110324	59	6915	*****	*****	*****	*****
37								TOTAL INC. TAX	90280								

Table 3.

and labels. This both saves time and avoids errors when setting up tables.

Once you establish the format, VisiCalc fills the columns automatically. The math is done in seconds right before your eyes, and the results can be output on your printer.

The accompanying sample tables show the information entered, including the constants used. VisiCalc recalculates the data instantly when any data, such as inflation rates or earnings, is changed. The beginning dollar amounts in the columns can be varied to suit individual investments or pensions.

The Tables Explained

The tables (1-6) assume a retired man born in 1920 with a wife two years younger. He plans to retire early, at age 60. He has about \$100,000 in savings and investments, and \$100,000 in an IRA or Keogh account which can be rolled over.

This rollover account is tax-sheltered until he reaches age 70 1/2 (1991). At that time, according to present Internal Revenue Service rules, he must liquidate the account in about 18 years. The money is fully

taxable as withdrawn. Withdrawals can be made earlier, and possibly should be, to minimize income taxes.

Here is a detailed explanation of the tables, by column:

Column A shows the years from 1980 to 2010; on the far left are line numbers for easy location of data points.

Columns B, C and D contain social security payments. Changing constants result in recalculation of inflation/COLA (cost of living adjustment) increases or investment returns. The percentage increases used also show up automatically at the top of columns B, C and E, and F and H, respectively.

Column E represents the whole reason of this exercise: spendable dollars after taxes. Annual increases to keep up with inflation can be varied by different multipliers. The increase is a straight percentage until 1990. After that the amounts are determined by what is available from columns D, G and H. E6 is the starting amount of personal budget needs.

Columns F and H contain the amounts of assets, tax-sheltered and liquid, respectively, as mentioned above. By entering different amounts

in locations F6 and H6, individual personal financial conditions will be displayed instead of the examples shown here.

Column G is for indicating amounts withdrawn from the tax-sheltered rollover account. While no withdrawals are required until 1991 by the IRS, minimizing income taxes indicates increasing payouts from this account as shown. Amounts from G6 to G16 are derived somewhat by trial and error to keep income taxes as low as possible and also to conserve sufficient liquid capital in column H. The quantity in location G17 has to be calculated from the dollar amount in F16. It is the amount needed to liquidate the tax-sheltered account starting in 1991.

Column I is the sum of column G plus earnings of column H.

Column J shows income taxes entered from special tables, which are shown together with the constants in Table 6. This table is strictly for the technical-minded. The Lookup Function of VisiCalc fills in the taxes. Total income taxes paid out from 1980 to 2010 are added into location J37, with the label indicating this.

Columns K and L are added to give

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
YEAR	SS HUSB.	SS WIFE	S.S.H+W	SPEND/	I.R.A.	WITHDRAW	LIQU. ASS.	TAXABLE	TAXES/	ASS. BEG.	% OF 1980	VALUE IN	GRAPHIC DISPLAY		
	% INCREASE		/MONTH	MONTH	AT %	FROM IRA	AT %	INCOME	YEAR	OF YEAR	DOLLARS	1980 \$'S	OF ASSETS FROM		
				%									COLUMN "K"		
6	1980	5.50	5.50	1600	5.50	100000		11000	530	200000	100	1600	#####	#####	
7	1981			1688	12.00	107000		91270	1200	198270	100	1688	#####	#####	
8	1982			1781		114840	5000	84854	14334	199694	100	1781	#####	#####	
9	1983	560		1879		121621	7000	76768	15444	198388	100	1879	#####	#####	
10	1984	591		1982		127215	9000	75187	17271	202402	100	1982	#####	#####	
11	1985	623	312	2091		130481	12000	74161	20158	204642	100	2091	#####	#####	
12	1986	658	329	2206		132139	14000	78245	22607	210383	100	2206	#####	#####	
13	1987	694	347	2327		132996	15000	83514	24187	216510	100	2327	#####	#####	
14	1988	732	366	2455		131955	17000	89258	26818	221213	100	2455	#####	#####	
15	1989	772	386	2591		127790	20000	96185	30580	223974	100	2591	#####	#####	
16	1990	815	407	2733		123124	20000	104877	31536	228001	100	2733	#####	#####	
17	1991	859	430	3316		120916	16983	104877	28520	225793	115	2883	#####	#####	
18	1992	907	453	3387		118443	16983	104877	28520	223320	111	3042	#####	#####	
19	1993	957	478	3461		115673	16983	104877	28520	220550	108	3209	#####	#####	
20	1994	1009	505	3540		112570	16983	104877	28520	217447	105	3386	#####	#####	
21	1995	1065	532	3624		109095	16983	104877	28520	213973	101	3572	#####	#####	
22	1996	1123	562	3711		105204	16983	104877	28520	210081	98	3768	#####	#####	
23	1997	1185	593	3804		100845	16983	104877	28520	205722	96	3976	#####	#####	
24	1998	1250	625	3902		95963	16983	104877	28520	200840	93	4194	#####	#####	
25	1999	1319	659	4005		90496	16983	104877	28520	195373	91	4425	#####	#####	
26	2000	1391	696	4114		84372	16983	104877	28520	189249	88	4668	#####	#####	
27	2001	1468	734	4229		77513	16983	104877	28520	182390	86	4925	#####	#####	
28	2002	1549	774	4350		69832	16983	104877	28520	174709	84	5196	#####	#####	
29	2003	1634	817	4478		61228	16983	104877	28520	166105	82	5482	#####	#####	
30	2004	1724	862	4612		51592	16983	104877	28520	156470	80	5783	#####	#####	
31	2005	1819	909	4755		40800	16983	104877	28520	145678	78	6101	#####	#####	
32	2006	1919	959	4905		28713	16983	104877	28520	133590	76	6437	#####	#####	
33	2007	2024	1012	5063		15176	16983	104877	28520	120053	75	6791	#####	#####	
34	2008	2135	1068	5230		13	16983	104877	28520	104891	73	7165	#####	#####	
35	2009	2253	1126	5379		4297	7	104877	11544	530	104884	57	7559	#####	#####
36	2010	2377	1188	5565		4483	0	104877	11536	530	104877	56	7974	#####	#####
37								TOTAL INC. TAX	103440						

Table 4.

Table 4.

Table 5 is an example of retirement with a pension, smaller tax-sheltered plan and personal savings. Column N contains the amount of the pension. Such a table might be used by corporate planners wanting to show employees what to expect financially during retirement years. ■

10000	370
11000	530
12000	700
13000	850
14000	1050
15000	1200
16000	1400
17000	1600
18000	1800
19000	2000
20000	2200
21000	2400
22000	2700
23000	2900
24000	3000
25000	3400
26000	3600
27000	3900
28000	4200
29000	4500
30000	4700
31000	5000
32000	5300
33000	5600
34000	6000
35000	6300
36000	6700
37000	7000
38000	7500
39000	7700
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OSI Baud Mod

By Ronald W. Carr

There are a number of reasons why I built this circuit mod for my Superboard. I had spent several hours debugging an assembly-language program that was too long to assemble in one piece, and most of those hours were spent loading and saving pieces of source and object code at 300 baud. I knew there were four areas on the board marked proto—and they had to be there for some reason. I had an idea for a modification to speed up loading and saving, and I had to see whether it would work. Construction began the next day.

I was hesitant about soldering on my new Superboard, but I'm glad I proceeded. The modification is not difficult if you have some experience working on circuit boards. Four ICs are used, but some gates aren't, so not too much work is involved. Parts, including sockets for the ICs, can be bought at Radio Shack for under \$10. Construction will probably take about four hours if you are as careful as I was when building. Then you will be saving BASIC programs at 600 baud—twice as fast.

Design

The basic design principle of the circuit is simple—in a word, redundant. The existing circuit that clocks the ACIA serial port is duplicated, except for the addition of a multiplexer that allows the selection of different input clocks to the ACIA.

There are good reasons for doing things this way. The original circuit supplies a clock to the Kansas City transmitter as well as to the ACIA. The clock to the transmitter must remain at 4800 Hz, or the tones that are recorded will be too high a frequency for both the recorder and the Kansas City receiver circuit.

Duplicating the circuit allows for separate clocking sources for the ACIA and the transmitter circuit. These separate clocks remain synchronous (i.e., they change states simultaneously) because the circuit is duplicated and because the existing divider chain is synchronous. For proper operation the clocks must be synchronous.

The other reason I chose to duplicate the existing circuit is that foil cuts are required only at W5, a hard-wire jumper section included on the board so that you can easily change the clock to the ACIA. Thus, the original circuitry is kept intact.

Let's look at Fig. 1. The signals C2, C3 and C4 are obtained from the existing divider chain. I'll tell you good places to find these later. U44 is a data selector or multiplexer which, depending upon the position of SW1, selects C2, C3 or C4 for a clock to U26. U26 and U27 form a divide-by-13 counter. State 12 is decoded by U27, and, when the next clock pulse arrives, all zeros are loaded using the parallel inputs. U28 divides the output of U26 by two, and makes the waveform symmetrical. The output of U28 is used as the new clock for the 6850 ACIA.

Construction

I suggest that care be taken during construction so that any problems during checkout will be simple to solve. I labeled pin 1 of each IC on the bottom of the board with a felt-tip pen, and also labeled the +5 and ground foil runs. You should verify these with an ohmmeter before you start. Remove the board from its case, and label any wires that need to be disconnected to aid in reassembly.

74LS161—Install a 16-pin socket at

the proto area designated U26 (refer to the user's manual for the location of U26). Pin 1 is located toward the keyboard. Mark pin 1, and then connect pins 1, 7, 10 and 16 to the +5 V bus. Connect pins 3, 4, 5, 6 and 8 to ground.

74LS00—Install a 14-pin socket at proto area U27. Again, mark pin 1 on the bottom of the board. Wire pins 1, 2, 9, 10, 12, 13 and 14 to +5. Wire pin 7 to ground.

74LS74—Install a 14-pin socket to U28. Wire pins 1, 4, 10, 11, 12, 13 and 14 to +5. Wire pin 7 to ground. Wire pin 6 to pin 2.

74LS151—Install a 16-pin socket at U44. Wire pins 4, 7, 8 and 9 to ground. Install a 4.7k resistor from pin 11 to +5 V and another 4.7k resistor from pin 10 to the +5 V bus. While installing these resistors, use the lead of one to also wire pins 12, 13, 14, 15 and 16 to the +5 V bus.

Following the signal path of Fig. 1, run a wire from U44, pin 5, to U26, pin 2. Connect pin 12 of U26 to pin 4 of U27. Connect pin 3 of U28 to pin 11 of U26 and to pin 5 of U27. Break the foil connections inside W5 and run a wire from the TX and RX ACIA inputs to pin 5 of U28. Finally, connect U27, pin 6, to U26, pin 9.

Now, pins 1, 2 and 3 of the 74LS151 (U44) must be connected to C4, C3 and C2.

C4—Locate U57 on the board. Pin 2 of U57 runs to a through-hole just below the IC (away from the keyboard). Run a wire from this through-hole to pin 1 of U44.

C3—Directly below U30 is a through-hole. Run a wire from it to

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Minding Your P's and Q's

By Richard R. Parry

Your word-processing system enhances the cosmetic quality of text. Now all you need is some software to improve the writing.

The program described here helps do just that. It analyzes ordinary English text and computes the number of lines, sentences, words and syllables and the average word and sentence length. Then it gives a readability score.

You can also construct a concordance or frequency table of words. For example, this article contains 173 sentences, 3332 words and 5268 syllables, with average word and sentence lengths of 4.74 and 19.26, respectively. [Before editing—Eds.] The readability test indicates that this article should be easily comprehended by a person with an 11th grade reading level. In addition, a concordance table shows that the words "the," "of" and "to" appear 248, 130 and 85 times, respectively.

Armed with the result of the analysis, a writer can make his or her text more readable to the group he or she has targeted. For example, a good manager who is planning to distribute a paper describing a company-wide policy to all employees would not want the readability level to be that of a college student, since the reading level of the employees will most likely cover a wide range. The manager should strive to ensure that the level is sufficiently low to be easily

comprehended by all employees.

Readability

Readability is the measurement of the comprehensibility of printed material. Educators have developed many methods for measuring readability. For example, Dr. Rudolf Flesch in *The Art of Plain Talk* describes a method based on the theory that the closer a word is to its root, the easier it will be understood. Therefore, prefixes and suffixes attached to words detract from readability. The average sentence length and use of proper nouns are other factors encompassed by the theory to arrive at an overall readability score.

The Fog Index is another means. It is based on the average sentence length and the percentage of "hard" words, which are uncommon words of three or more syllables. Other methods include the SRA, Botel, Dale-Chall and Fry readability tests.

The BASIC program shown in Listing 1 uses a readability method developed by Dr. Edward Fry. The technique is discussed by Dr. Fry in an article entitled, "A Readability Formula That Saves Time," which appeared in the April 1968 issue of the *Journal of Reading*. Ironically, the title is somewhat of a misnomer, since a graph and not a formula is used to arrive at a reading level. Variables used by the graph are sentences and syllables.

The original analysis method required a person to compute the average sentence length and the average number of syllables for three 100-word samples of the text. A better analysis could be derived if one analyzed the entire text; however, such a task for a human would indeed be tedious. Thanks to the computer, humanity is saved from this fate.

The results of the readability test yield one of 13 possible readability grade levels, ranging from first grade to college. A reading level of 12 represents the reading level of an average senior in high school.

A word of caution in interpreting reading scores: It is a mistake to think that a manuscript with a reading level of 12 is superior to one with a tenth grade level. In fact, one might argue that the converse is true, since the text with a tenth grade level can be comprehended by both a sophomore and a senior in high school, while the text with a readability level of 12 will be better understood by the senior. In actuality, each has its place. Prose should be written to meet the level of the group that will be reading it.

Richard R. Parry is an electrical engineer and programmer at the Fermi National Accelerator Laboratory, and teaches a course in Pascal at Elgin Community College in Illinois. His most recent article for Kilobaud Microcomputing was "Math Teacher," in the April issue. He can be reached at 38 W. 255 Deerpath Road, Batavia, IL 60510.

There are, of course, many factors affecting readability that the simple examination of the length of sentences and the number of syllables cannot take into account. The background of the reader and the interest that the text creates are important variables difficult to measure. In addition, readability formulas do not indicate conceptual difficulty due to unusual use of words, word order or the ratio of abstract to concrete terms. As Fry himself admits, the readability level computed using his graph is probably accurate to within a grade level.

Given these shortcomings, readability scores still serve as one important yardstick for measuring readability and aiding both an author to improve writing skills and an instructor to provide appropriate reading material.

Using the Program

The program begins by reminding the user that if a valid readability level is required, the minimum sample size of the text should not be less than 300 words. With this caveat understood, the user is then given the opportunity to indicate if the source of the text will be the computer's terminal or a text file.

Sample 1 shows how the user would input text from the terminal's keyboard. After indicating the source of the input, the user may also request a concordance table. Concordance tables come in a variety of forms. The table constructed by this program is basically a frequency table showing the number of times each unique word in the text occurs.

Assuming the table is not desired, the user responds with "N" for no. With these simple initialization steps complete, the user is prompted to input text. The text given by the user is analyzed by the computer one line at a time. When all text has been given, the user types a backslash character (\) on a new line to indicate the end of the text. The program then computes and displays the results of the analysis.

The results of the analysis for the text in Sample 1 shows that it consists of 34 lines, 19 sentences, 350 words and 567 syllables. In addition, the average word length is 4.78, and the average sentence is 18.42 words long. The readability test indicates that the text is written at a tenth grade reading level, which implies that a sophomore in high school should be able to com-

prehend the text with no difficulty.

Sample 2 shows the results of an analysis of the article you are now reading. The source of the input was a text file that was generated by a text editor and word processor. Using files to input text should be the more common means of supplying data to the program, since presumably the user has already prepared a letter or article as a file using a text editor and word processor. Most, if not all, word processors allow the user to direct the output to a file rather than to a terminal or printer. This file then serves as the input for the text analysis program. Note that even here, the end of text character is a backslash.

Since BASIC does not support a standard "end of file" function such as is found in Pascal or COBOL, it is necessary to edit the file to append the end of text character. Note that the values shown represent the specifications of the article as it was presented to the magazine's editor and possibly not as you see it in its present form.

After the user supplies the name of the file, the analysis begins. If the analysis is performed on a microcomputer, the user will have to exhibit some patience. Ideally, a program such as this should be written in assembly language or in a language that could be compiled. However, the program would then be much more limited. The execution time for the analysis varies linearly with the length of the text to be analyzed.

Of course, this time will vary greatly among computer systems, since the hardware as well as the version of BASIC will be major determining factors. On an SWTP computer with a Motorola 6800 running at 1 MHz with Technical Systems Consultant's version of BASIC, a 350 and 3000 word text analysis required 2.5 and 21 minutes, respectively.

The last example, Sample 3, shows how the program can be used to display a concordance table in addition to the text analysis. Assuming the text to be analyzed is a data file, the user starts the program as in Sample 2. However, when queried by the computer for a concordance table, the user responds with "Y."

The user now needs to approximate the number of unique words embodied in the text. This information is necessary since the words must be stored in an array and the computer must know how much memory to allocate. After the user re-

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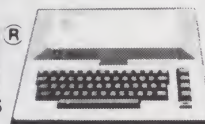
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Listing 1. Complete BASIC program for the English text analysis and concordance program. No references are made to the REM statements; therefore, to conserve memory they may be removed.

```

100 REM *****
110 REM *
120 REM *   ENGLISH TEXT ANALYSIS AND CONCORDANCE PROGRAM   *
130 REM *
140 REM *
150 REM *           BY
160 REM *       RICHARD R. PARRY
170 REM *       JANUARY 1981
180 REM *
190 REM * THIS PROGRAM ACCEPTS ORDINARY ENGLISH TEXT AND COMPUTES
200 REM * THE NUMBER OF: LINES, WORDS, SENTENCES, AND SYLLABLES
210 REM * AS WELL AS THE AVERAGE WORD AND SENTENCE LENGTH.
220 REM * A READABILITY SCORE IS ALSO GIVEN. IF THE USER DESIRES
230 REM * A CONCORDANCE TABLE MAY BE CONSTRUCTED.
240 REM *
250 REM *   LC.....LINE COUNTER
260 REM *   SC.....SENTENCE COUNTER
270 REM *   WC.....WORD COUNTER
280 REM *   SM.....LETTER COUNTER
290 REM *   SK.....SYLLABLE COUNTER
300 REM *   NW.....UNIQUE WORD COUNTER
310 REM *****
320 PRINT "NOTE!!! READABILITY TEST REQUIRES SAMPLE OF AT LEAST 300 WORDS"
330 PRINT "FOR BEST RESULTS."
340 PRINT : PRINT
350 INPUT "INPUT VIA KEYBOARD OR DISK (K/D)", QS$
360 IF QS$ <> "K" AND QS$ <> "D" THEN PRINT "K OR D PLEASE": GOTO 350
370 INPUT "STORE WORDS FOR FREQUENCY ANALYSIS (Y/N)", ST$
380 IF ST$ <> "Y" AND ST$ <> "N" THEN PRINT "Y OR N PLEASE": GOTO 370
390 IF ST$ = "N" THEN 430
400 INPUT "NUMBER OF DIFFERENT WORDS EXPECTED", DW
410 DIM W$(DW): REM CONCORDANCE WORD ARRAY
420 DIM F(DW): REM FREQUENCY ARRAY OF EACH WORD
430 IF QS$ = "D" THEN 470
440 PRINT "TERMINATE TEXT WITH A SINGLE LINE"
450 PRINT "CONSISTING OF ONLY A BACKSLASH (I.E. \)"
460 GOTO 490
470 INPUT "NAME OF FILE TO ANALYZE": NF$
480 OPEN OLD NF$ AS 1
490 IF QS$ = "K" THEN INPUT LINE A$ ELSE INPUT LINE #1, A$: PRINT "X";
500 IF LEN(A$) = 1 AND A$ = "\" THEN 1050: REM CHECK FOR END OF TEXT
510 IF LEN(A$) = 0 THEN 490: REM NULL INPUT STRING
520 A$ = A$ + " ": REM APPEND A SPACE CHARACTER TO EOL
530 EN = LEN(A$): REM INITIALIZE LENGTH OF LINE
540 LC = LC + 1: REM INCREMENT LINE COUNTER
550 CO = 0: REM INITIALIZE WORD LENGTH COUNTER
560 WF = 0: REM INITIALIZE WORD FLAG
570 REM *****
580 REM * ANALYZE INPUT LINE CHARACTER BY CHARACTER CHECKING FOR A WORD *
590 REM * OR SENTENCE *
600 REM *****
610 FOR I = 1 TO EN
620   CH$ = MID$(A$, I, 1)
630   REM *****
640   REM * TEST FOR SENTENCE WHICH IS A . OR ? OR ! PRECEDED *
650   REM * BY A WORD WITH LENGTH >1 CHARACTER AND FOLLOWED BY A SPACE *
660   REM *****
670   ES = 0
680   NC$ = MID$(A$, I + 1, 1): REM SAVE NEXT CHARACTER
690   IF CH$ = "." OR CH$ = "?" OR CH$ = "!" THEN ES = 1
700   IF ES = 1 AND (CO > 1 OR PC$ = CHR$(34)) AND NC$ = " " THEN SC = SC + 1
710   REM *****
720   REM * TEST FOR A WORD WHICH IS DETERMINED BY THE PRESENCE OF *
730   REM * SPACE , , ; : ? ! " ( ) *
740   REM *****
750   IF CH$ = " " OR CH$ = CHR$(34) OR CH$ = "(" OR CH$ = ")" THEN 800
760   IF CH$ = ":" OR CH$ = ";" OR CH$ = "?" OR CH$ = "!" THEN 800
770   IF CH$ = "." OR CH$ = "!" THEN 790
780   CO = CO + 1: WF = 1: GOTO 990
790   IF MID$(A$, I + 1, 1) <> " " THEN CO = CO + 1: GOTO 1000
800   IF WF = 0 THEN 990: REM LETTER MUST PRECEED PRESENT LETTER
810   SM = SM + CO: REM INCREMENT LETTER COUNTER
820   WC = WC + 1: REM INCREMENT WORD COUNTER
830   WF = 0: REM RESET WORD FLAG
840   WR$ = MID$(A$, I - CO, CO): REM ANALYZE WORD FOR SYLLABLES
850   GOSUB 2170: REM INCREMENT TOTAL SYLLABLE COUNTER
860   SK = SK + SY
870   IF ST$ = "N" THEN 980: REM SKIP CONCORDANCE STORING ROUTINE
880   REM *****
890   REM * SEARCH TABLE FOR WORD. IF NEW WORD ADD TO LIST *
900   REM * IF OLD WORD, INCREMENT FREQUENCY COUNTER *
910   REM *****
920   FOR J = 1 TO NW
930     IF W$(J) = WR$ THEN F(J) = F(J) + 1: GOTO 980
940   NEXT J
950   NW = NW + 1: REM INCREMENT "NEW" WORD COUNTER
960   W$(NW) = WR$: REM STORE NEW WORD
970   F(NW) = 1: REM NEW WORD. THERE IS ONLY ONE
980   CO = 0: REM ZERO WORD CHARACTER COUNTER
990   PC$ = CH$: REM SAVE PREVIOUS CHARACTER
1000 NEXT I
1010 GOTO 490
1020 REM *****
1030 REM * TEXT ANALYSIS COMPLETE. DISPLAY RESULTS SPECIFIED BY USER *
1040 REM *****
1050 IF ST$ = "N" THEN 1560
1060 PRINT : PRINT : PRINT
1070 PRINT "*** ANALYSIS OPTIONS ***": PRINT
1080 PRINT "1. FREQUENCY SORT"
1090 PRINT "2. ALPHABETIC SORT"

```

sponds to the question and supplies the name of the text file, the computer begins the analysis.

Two points are worthy of note in reference to using the concordance feature of the program. The first is the amount of time required to execute the program. While a large-scale computer can analyze long manuscripts in moments, a microcomputer using a BASIC interpreter requires much more time. For example, a 1100 word manuscript that required nine minutes to analyze without a concordance table required 21 minutes when the concordance table was requested.

Second, the construction of a concordance table requires a good deal of memory since all words that make up the table must be simultaneously in memory. Most microcomputer systems with 16K of memory available for variables should be able to construct a table of 900 words. For most articles this should be adequate since an average article of 3000 words will most likely have less than 900 unique words.

When the analysis is complete, the user is shown a menu from which he or she may indicate the information desired and the format the data is to take. You can request that the concordance table be displayed in alphabetical order, in order of highest frequency, or merely unsorted. Sorting is another time-consuming process that the user should be aware of if a microcomputer is being used. Sorting 400 words on the computer system mentioned above requires 25 minutes. Sample 3 shows the table sorted according to frequency.

Notice that the word "the" is considered to be different from the word "The." It is possible to convert all uppercase characters to lowercase so that this apparent oddity will not occur. However, converting the case of the characters leads to an even more undesirable situation. Names such as "John Q. Public" and "Illinois" would then be shown in the table as "john q. public" and "illinois," which would be even more incorrect.

About the Program

After many years of programming, one thing has become apparent to me: most programming projects that at first seem innocuous are anything but. The present program is no exception. Parsing a line of text for words and sentences at first glance

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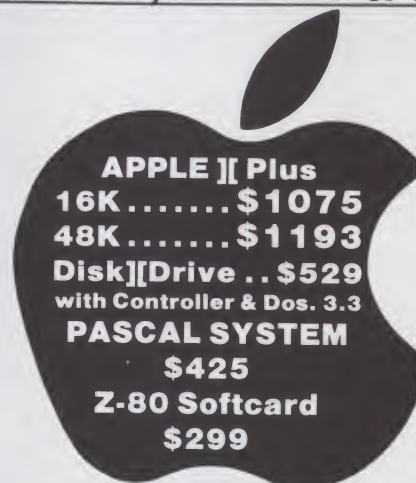
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Listing 1 continued.

```

1100 PRINT "3. NO SORT"
1110 PRINT "4. STATISTICS ONLY"
1120 PRINT "5. END"
1130 PRINT : PRINT
1140 INPUT "SELECT OPTION (1,2,3,4,5)"; QS
1150 IF QS <1 OR QS >5 THEN 1060
1160 ON QS GOTO 1200, 1340, 1480, 1560, 2090
1170 REM *****
1180 REM * BUBBLE SORT ACCORDING TO FREQUENCY *
1190 REM *****
1200 PRINT : PRINT "*** SORTING IN PROGRESS ***"
1210 FL = 0
1220 FOR K = 1 TO NW -1
1230 IF F(K) >= F(K+1) THEN 1280
1240 SW = F(K) : S$ = W$(K)
1250 F(K) = F(K+1) : W$(K) = W$(K+1)
1260 F(K+1) = SW : W$(K+1) = S$
1270 FL = 1
1280 NEXT K
1290 IF FL = 1 THEN 1210
1300 GOTO 1480 : REM SORT COMPLETE, DISPLAY TABLE
1310 REM *****
1320 REM * BUBBLE SORT ACCORDING TO ALPHABETIC *
1330 REM *****
1340 PRINT : PRINT "*** SORTING IN PROGRESS ***"
1350 FL = 0
1360 FOR K = 1 TO NW -1
1370 IF W$(K) <= W$(K+1) THEN 1420
1380 SW = F(K) : S$ = W$(K)
1390 F(K) = F(K+1) : W$(K) = W$(K+1)
1400 F(K+1) = SW : W$(K+1) = S$
1410 FL = 1
1420 NEXT K
1430 IF FL = 1 THEN 1350
1440 GOTO 1480 : REM SORT COMPLETE, DISPLAY TABLE
1450 REM *****
1460 REM * PRINT FREQUENCY DISTRIBUTION TABLE *
1470 REM *****
1480 PRINT : PRINT : PRINT TAB(7) ; "*** CONCORDANCE TABLE ***"
1490 PRINT : PRINT "WORD $ WORD FREQUENCY"
1500 FOR K = 1 TO NW
1510 PRINT K, W$(K), F(K)
1520 NEXT K
1530 REM *****
1540 REM * PRINT TEXT STATISTICAL ANALYSIS *
1550 REM *****

```

More →

seems easy. Sentences could be counted by merely noting the number of periods. Words could be counted by counting the number of spaces. However, the number of anomalies in the English language requires more sophisticated algorithms for an accurate word and sentence count. The program contains three major algorithms that are worthy of special note and explanation—the sentence, word and syllable algorithms.

Before discussing the specifics of the algorithms, I should mention that I had to make a trade-off early in the design phase of the sentence algorithm. Either the algorithm could be made very accurate for nonfiction, or mediocre for prose in general. I chose the former, because of the way periods, question marks and other sentence-terminating characters are used in fiction and nonfiction.

Typically in nonfiction, a period is preceded by a word and followed by a space. This is not true in fiction. Fiction is inundated with the quotations of characters in the story. The quotation marks surrounding the remarks of the story's characters break the sentence rule mentioned. Targeting the program for nonfiction writers

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seems a reasonable trade-off, since I suspect that this program will rarely, if ever, be used by fiction writers.

The first approximation at a sentence counter algorithm would, of course, count periods. However, if a sentence contained the name "John Q. Public," the period after the letter "Q" would cause a sentence miscount. This inaccuracy is overcome by checking that more than one character precedes the period. It is true that one could think of cases in which the algorithm fails, such as the sentence, "He is a better chess player than I." Here the period after the word "I" would not denote a sentence, because the sentence ends with a single character word. However, after studying hundreds of sentences in ordinary text, I rarely found sentences that fooled the algorithm.

Our sentence algorithm must be further enhanced before we can be confident in its accuracy. If, for example, some text contained a number such as 47.12, the decimal point (period) following the first two digits would be construed as indicating the end of a sentence, which, of course, it is not. This dilemma is solved by

Listing 1 continued.

```

1560 SK = INT(SK * .99 + .5) : REM INACCURATE SYLLABLE ALGORITHM REDUCE 1
1570 PRINT : PRINT : PRINT
1580 PRINT "*** TEXT ANALYSIS STATISTICS ***" : PRINT
1590 PRINT "NUMBER OF LINES " : LC
1600 PRINT "NUMBER OF SENTENCES " : SC
1610 PRINT "NUMBER OF WORDS " : WC
1620 PRINT "NUMBER OF SYLLABLES " : SK
1630 PRINT "AVERAGE WORD LENGTH " : INT(SH/WC * 100 + .5) / 100
1640 PRINT "AVERAGE SENTENCE LENGTH " : INT(WC / SC * 100 + .5) / 100
1650 IF WC > 300 THEN 1740
1660 PRINT "*** FOR MOST ACCURATE RESULTS, THE READABILITY TEST REQUIRES ***"
1670 PRINT "*** A SAMPLE OF GREATER THAN 300 WORDS. THEREFORE, GRADE ***"
1680 PRINT "*** LEVEL GIVEN BELOW MAY BE INACCURATE. ***"
1690 REM *****
1700 REM * BASED ON THE NUMBER OF SYLLABLES AND SENTENCES DISCOVERED, FIND *
1710 REM * THE GRADE LEVEL AT WHICH THE TEXT WAS WRITTEN. FIRST NORMALIZE *
1720 REM * TO 100 WORD SAMPLE TO USE DR. FRY'S GRAPH. *
1730 REM *****
1740 NS = SC * 100.0 / WC : REM NORMALIZE # OF SENTENCES TO 100 WORD SAMPLE
1750 NY = SK * 100.0 / WC : REM NORMALIZE # OF SYLLABLES TO 100 WORD SAMPLE
1760 DIM S(12) , Y(12) : REM SENTENCE & SYLLABLE VALUES FOR FRY'S GRAPH
1770 IF NY < 108 OR NY > 172 OR NS < 3.6 OR NS > 25 THEN 1780 ELSE 1800
1780 PRINT "*** DATA GIVEN IS OUTSIDE VALID RANGE FOR READABILITY TEST ***"
1790 GOTO 2080
1800 S(12) = .283 * NY - 41.7 : Y(12) = 3.46 * NS + 147.7
1810 S(11) = .191 * NY - 25.8 : Y(11) = 5.17 * NS + 135.4
1820 S(10) = .177 * NY - 22.7 : Y(10) = 5.58 * NS + 128.6
1830 S(9) = .184 * NY - 22.8 : Y(9) = 5.36 * NS + 124.2
1840 S(8) = .158 * NY - 17.6 : Y(8) = 6.20 * NS + 112.0
1850 S(7) = .137 * NY - 13.6 : Y(7) = 7.18 * NS + 99.8
1860 S(6) = .170 * NY - 16.0 : Y(6) = 5.77 * NS + 94.3
1870 S(5) = .161 * NY - 13.1 : Y(5) = 6.01 * NS + 82.6
1880 S(4) = .173 * NY - 13.6 : Y(4) = 5.64 * NS + 79.9
1890 S(3) = .222 * NY - 18.6 : Y(3) = 4.37 * NS + 84.7
1900 S(2) = .305 * NY - 25.7 : Y(2) = 3.21 * NS + 85.2
1910 S(1) = .469 * NY - 41.5 : Y(1) = 2.08 * NS + 89.5
1920 IF NS < S(12) AND NY > Y(12) THEN GR = 13
1930 IF NS > S(12) AND NS <= S(11) AND NY < Y(12) AND NY >= Y(11) THEN GR = 12
1940 IF NS > S(11) AND NS <= S(10) AND NY < Y(11) AND NY >= Y(10) THEN GR = 11
1950 IF NS > S(10) AND NS <= S(9) AND NY < Y(10) AND NY >= Y(9) THEN GR = 10
1960 IF NS > S(9) AND NS <= S(8) AND NY < Y(9) AND NY >= Y(8) THEN GR = 9
1970 IF NS > S(8) AND NS <= S(7) AND NY < Y(8) AND NY >= Y(7) THEN GR = 8
1980 IF NS > S(7) AND NS <= S(6) AND NY < Y(7) AND NY >= Y(6) THEN GR = 7
1990 IF NS > S(6) AND NS <= S(5) AND NY < Y(6) AND NY >= Y(5) THEN GR = 6

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Listing 1 continued.

```

2000 IF NS> S(5) AND NS<= S(4) AND NY< Y(5) AND NY>= Y(4) THEN GR = 5
2010 IF NS> S(4) AND NS<= S(3) AND NY< Y(4) AND NY>= Y(3) THEN GR = 4
2020 IF NS> S(3) AND NS<= S(2) AND NY< Y(3) AND NY>= Y(2) THEN GR = 3
2030 IF NS> S(2) AND NS<= S(1) AND NY< Y(2) AND NY>= Y(1) THEN GR = 2
2040 IF NS> S(1) AND NY< Y(1) THEN GR = 1
2050 PRINT "BASED ON NUMBER OF SENTENCES AND SYLLABLES "
2060 PRINT " YOUR READABILITY GRADE LEVEL IS "
2070 IF GR = 13 THEN PRINT "COLLEGE" ELSE PRINT GR
2080 IF ST$ = "Y" THEN 1060 : REM RETURN TO MENU
2090 END
2100 REM *****
2110 REM * COUNT SYLLABLES IN WORD. A SYLLABLE COUNTER IS INCREMENTED *
2120 REM * EACH TIME A VOWEL OR Y IS FOUND. HOWEVER, THEY MUST BE *
2130 REM * SEPARATED BY A DIFFERENT CHARACTER. IN ADDITION, EACH WORD *
2140 REM * MUST HAVE AT LEAST ONE SYLLABLE. IF THE WORD ENDS IN "E" *
2150 REM * THE COUNTER IS DECREMENTED. *
2160 REM *****
2170 SY = 0 : REM INITIALIZE SYLLABLE COUNTER
2180 SF = 0 : REM INITIALIZE SYLLABLE FLAG
2190 FOR L = 1 TO CO
2200 CR$ = MID$(WR$,L,1)
2210 IF CR$="a" OR CR$="e" OR CR$="i" THEN 2260
2220 IF CR$="o" OR CR$="u" OR CR$="y" THEN 2260
2230 IF CR$="A" OR CR$="E" OR CR$="I" THEN 2260
2240 IF CR$="O" OR CR$="U" OR CR$="Y" THEN 2260
2250 SF = 0 : GOTO 2290
2260 IF SF = 1 THEN 2290
2270 SY = SY + 1 : REM INCREMENT SYLLABLE COUNTER
2280 SF = 1 : REM SET SYLLABLE FLAG
2290 NEXT L
2300 IF CR$ = "E" OR CR$ = "e" THEN SY = SY - 1
2310 IF SY < 1 THEN SY = 1: REM 1 SYLLABLE MINIMUM
2320 RETURN

```

Sample 1. This sample run shows how text which is to be analyzed is given by the user from the terminal's keyboard. The output indicates the number of lines, sentences, words and syllables. The average word and sentence length is also displayed in addition to the readability level. The text is an excerpt from Collier's Encyclopedia.

NOTE!!! READABILITY TEST REQUIRES SAMPLE OF AT LEAST 300 WORDS FOR BEST RESULTS.

```

INPUT VIA KEYBOARD OR DISK (K/D)? K
STORE WORDS FOR FREQUENCY ANALYSIS (Y/N)? N
TERMINATE TEXT WITH A SINGLE LINE
CONSISTING OF ONLY A BACKSLASH (I.E. \)
? The whale is an aquatic mammal that breathes air but cannot
? survive on dry land. It is the largest known mammal and lives in the
? ocean where it must surface at intervals to obtain air. A whale
? bears a superficial resemblance to the fishes in external form and
? is streamlined for an aquatic life. Its general body form is round,
? elongate, and tapered posteriorly to a pair broad, flattened,
? horizontal flukes. The flukes, which make up the tail, are notched
? in the middle, have no bony support, and serve as the propellers
? force that drives the animal through the water. They are made up of
? cartilaginous tissue and are placed in a horizontal position. The
? forelimbs or flippers of the whale correspond to the arms and hands
? of land mammals. The parts that correspond to the fingers and hands
? are encased in a cartilaginous covering of skin and are shaped like
? a paddle. They serve as stabilizers to maintain an even keel for the
? animal. The whale has no hind legs although remnants of a pelvis and
? limb bones are found in the fleshy parts of some species.
? Most modern whaling is carried out on the high seas,
? or at least beyond the three-mile limit.
? Whales generally are available to whalers of any nation,
? and floating-factory ships operating on a pelagic basis
? take more whales than the more numerous shore stations.
? Consequently, the regulation of whaling for the conservation
? of the stock must be done mainly by international law on the
? basis of treaties.
? Whaling regulations have been in existence for centuries.
? However, they have not been completely successful in curtailing
? overhunting, and the depletion of whale populations has been
? quite rapid. The first species to be depleted was the humpback.
? Then the blue whale, the most desirable species, showed a
? population decrease. For example, the Antarctic population of blue
? whale averaged about 14,500 in the 1930's. By the early 1960's
? population figures had dropped to about 2,000, and in 1968 it was
? estimated that only about 600 of the animals were left in the
? vast ocean surrounding the Antarctic.
\

```

*** TEXT ANALYSIS STATISTICS ***

```

NUMBER OF LINES 34
NUMBER OF SENTENCES 19
NUMBER OF WORDS 350
NUMBER OF SYLLABLES 551
AVERAGE WORD LENGTH 4.78
AVERAGE SENTENCE LENGTH 18.42
BASED ON NUMBER OF SENTENCES AND SYLLABLES
YOUR READABILITY GRADE LEVEL IS 10

```

checking for a space after the period. However, even here we can get into difficulty if the period is the last character in the line. Therefore, a space character is appended to each line of text that is read to ensure an accurate sentence count using this algorithm. Adding a space to the end of the line also simplifies the word algorithm which will be discussed shortly.

Lastly, since sentences may terminate with a question mark or exclamation point as well as a period, these characters are also encompassed by the algorithm and treated in the same manner as a period.

The word algorithm is a real bucket of worms. It must properly detect and extract a word from a line and delete excess punctuation marks or characters, such as spaces, periods, commas, question marks and others that appear in normal text. It is true that words could be accurately counted by merely counting spaces or groups of spaces between nonspace characters. However, to accurately construct a concordance table, the word must be extracted from punctuation marks that may surround it. For example, if the word "standard" appeared in text with quotation marks on either side of it, and later appeared without quotes around it, we would still consider them to be the same word. We must, therefore, force the program to also consider them the same word. This necessitates removal of punctuation marks, with demands a more complex algorithm.

The nine punctuation marks that appear commonly in English text and must be detected and treated properly are colons, semicolons, quotation marks, question marks, exclamation points, right and left parentheses, commas and periods. The first seven are removed whether they appear at the beginning or end of a word. Therefore, the word "standard" in quotes would be displayed in the concordance table without quotes.

The comma and period are treated differently, since in the case of numbers, we would want to save them as part of the number. They are thus removed only if followed by a space and preceded by a character other than the nine punctuation marks mentioned. In this way, a number such as 2.4 would be labelled a single word, as would the dollar amount \$2,134.98.

In addition, an ellipsis (...) would not be considered a word. Nor would it be considered three sentences ac-

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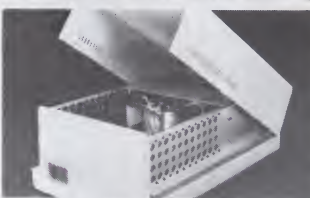
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An additional study of 3000 words of running text containing nearly 5000 syllables was made to further

WORD #	WORD	FREQUENCY
1	the	30
2	of	13
3	and	12
4	in	11
5	to	9
6	a	8
7	whale	7
8	are	7
9	The	6
10	is	5
11	that	4
12	on	4

More

verify the accuracy of the syllable algorithm (counting several thousand syllables has to rank as one of the more boring tasks of life). The results of this second study showed the algorithm to be virtually perfect. A compromise was struck between the results found for each study. The final value displayed as the syllable count is reduced by 1 percent to yield an exceptionally accurate syllable count.

Conclusion

A text analysis program is the next logical step after the word processor toward better writing. Readability scores are not a sure measure of effective communication, but used in conjunction with other techniques, they serve as the basis for unbiased comparison.

Several times throughout the article I have mentioned that the execution time of the analysis is slow due mainly to the use of a microcomputer and a BASIC interpreter. However, you should remember that the computer is doing the work and not you. Go have a cup of coffee, relax and think of your next article while you are waiting. ■

Sample 3 continued.

.	.	.
.	.	.
.	.	.
.	.	.
190	had	1
191	dropped	1
192	2,000	1
193	1968	1
194	estimated	1
195	only	1
196	600	1
197	animals	1
198	were	1
199	left	1
200	vast	1
201	surroundings	1

*** TEXT ANALYSIS STATISTICS ***

NUMBER OF LINES 34
 NUMBER OF SENTENCES 19
 NUMBER OF WORDS 350
 NUMBER OF SYLLABLES 551
 AVERAGE WORD LENGTH 4.78
 AVERAGE SENTENCE LENGTH 18.42
 BASED ON NUMBER OF SENTENCES AND SYLLABLES
 YOUR READABILITY GRADE LEVEL IS 10

*** ANALYSIS OPTIONS ***

1. FREQUENCY SORT
2. ALPHABETIC SORT
3. NO SORT
4. STATISTICS ONLY
5. END

SELECT OPTION (1,2,3,4,5)? 5

MY COMPUTER IS GOING CRAZY AGAIN
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HERE, LET ME TRY THIS..., AND THIS...AND THERE!

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By Douglas H. Haden



Photo 1. The TASA Model 55 Keyboard The fully-sealed polycarbonate keyboard contains the electronics for 55 microproximity sensor pads, 128-position ASCII encoding, parity and strobe. The four-color layout, sizing and choice of nomenclature result in a friendly-appearing keyboard.

I became interested in the TASA keyboard while seeking some alternative to spending many hours a day hunched over a typewriter. My dream was a keyboard that I could use while I twisted and turned in an overstuffed chair. The TASA keyboard weighed about 20 ounces and could be used at a desk on its optional stand or laid in my lap.

It has met my needs well. I've dropped it, spilled coffee on it, sat on it, and generally abused it and have had no problems to date.

Manufactured by Touch Activated Switch Arrays and available from KLM Marketing, PO Box 1237, Los Altos, CA 94022, for \$75 plus \$5 postage and handling, the TASA model 55 keyboard is fully ASCII encoded, with parity and strobe, and is sealed

in a 6.25 x 15 inch monolith less than a third of an inch thick. Photo 1 shows the TASA 55 keyboard; Fig. 1 shows the key nomenclature and the encoded output.

The keys are activated by finger pressure on touch-pads on the four-color keyboard face, using neither contact closure nor mechanical motion. When a given key is activated, its encoded binary output (along with parity and strobe) is available at the output connector. All touch-pads, except the shift, shift-lock and control keys, feature two-key rollover; if more than one key is activated, no output is generated.

Interface Circuits

I interfaced my TASA keyboard to a Sol-20 microcomputer, but most of

the following discussion applies to any system. The only system-dependent aspect of the interface is generating a compatible strobe signal. The Sol-20 requires a six-microsecond, low-active pulse. The TASA keyboard supplies a continuous, high-active strobe as shown in Fig. 2. While the TASA strobe is ideal for audio feedback and autorepeat circuits, it had to be massaged for my microcomputer system.

The Strobe. The logic for creating a short, low-active strobe pulse from the TASA keyboard's strobe level is shown in Fig. 2b, and represents the only circuitry required to interface

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peat, turned out to be an improvement over the separate-repeat-key feature it replaced. This circuit (purchased from Lancaster's *CMOS Cookbook*, p. 258) waits just over half a second and then, if the input strobe is still active, generates strobe pulses at the rate of five per second. Thus, you need not depress two keys simultaneously; just keeping a key activated will cause it to begin repeating. The autorepeat logic is connected to the rest of the system by C_5 . Fig. 3 shows the complete interface circuit diagram.

Construction

Board layout and wiring are no problem at all. Built originally on an AP Products breadboard, the inter-

face was easy to transfer to the general-purpose IC board shown in Photo 2. The microcomputer is connected by a short ribbon cable (the interface board is physically mounted in my Sol-20 during operation) with a non-polarized female receptacle on the end connecting to the motherboard, and a 14-pin DIP on the interface end, which plugs into the empty socket shown on the board in Photo 2.

The keyboard is connected by a 20-foot ribbon cable—the interface is located in the microcomputer instead of between the keyboard and its stand to keep timing-critical pulses (such as the conditioned strobe) from having to travel over the longer cable. The 20-foot cable lets me take the

keyboard from my desk to my easy chair when that is more comfortable. Goal attained: no more hunching over a typewriter or fixed keyboard!

Component values are not especially critical. Just to simplify the board layout, I used a Beckman resistor network for all the pull-up resistors, R_8 – R_{15} , and the dual-555 key-click generator was constructed from a single 556 chip. The values of R_2 and C_1 are not critical for my system, as mentioned earlier, but may need to be changed if you are interfacing to a system other than Sol-20. The time relationship $T = 0.8R_2C_1$ can be used to select the values of R_2 and C_1 .

A Schmitt trigger can be used in place of the 7404 if it is needed to clean up the shape of the conditioned-strobe pulse. A 50 V dc tantalum was used for C_4 to keep the size small. Since the circuit isn't critical, plain old ceramic disk capacitors were used for C_2 and C_3 . (If the monostable false-triggers, connect a small disk capacitor from pin 4 to ground.)

The TASA Board—Pros and Cons

Generally, the TASA keyboard has met my expectations. Designed primarily for use in an "uncontrolled or hostile environment, where operator caution and care cannot be reasonably expected" (a perfect description of my shop/study), the keyboard is rugged and reliable. Its specs include an average expected life of ten years or 50,000 power-on hours (because the keyboard is completely electronic, its life is unaffected by the number of key strokes), operational temperature from -40°C to $+60^\circ\text{C}$, shock to 15 g's, and vibration to 1.5 g's (if the keyboard ever gets dirty you can toss it into the dishwasher).

The on-board electronics has its own regulator and needs only 18 V dc, unregulated, at a maximum of 35 mA. All outputs are open-collector type active pull-down logic and need pull-up resistors to drive TTL logic. The specs guarantee only enough power to drive one TTL load, but I have driven several with no problem. Some of the spare 7404 gates in the interface electronics can be used to drive more loads if needed. The outer left and right one-inch edges of the keyboard can be drilled for mounting holes if desired.

For all that, there are aspects of the TASA board that are less than ideal. The connector is a standard 0.156-

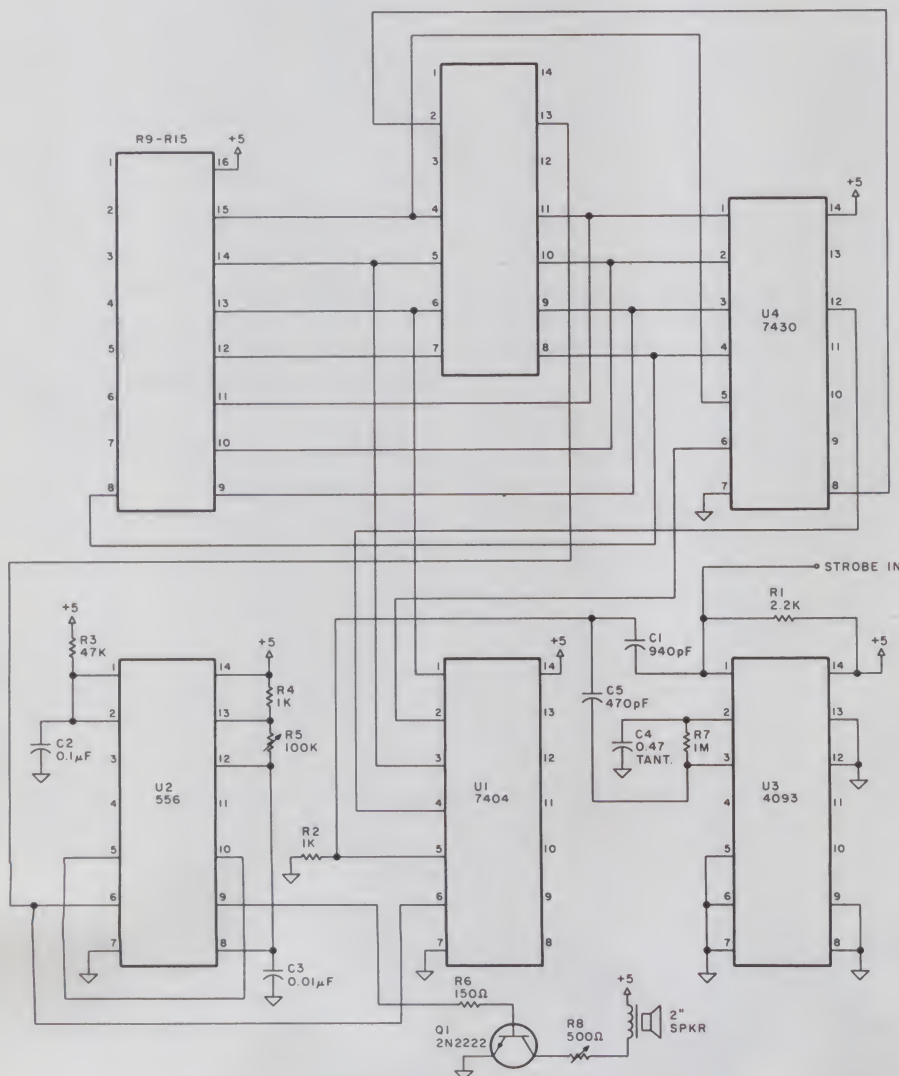


Fig. 3. The complete interface. The strobe is conditioned by a half-monostable (U_1). A dual-555 timer is used to generate an attractive bleep when a key is actuated (U_2); a 4093 CMOS astable generates the auto repeat (U_3); and an eight-wide NAND is used to decode system reset (U_4 and some of U_1). Note that one-half of U_1 is unused, as is three-fourths of U_3 .

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Photo 2. The author's completed interface. The keyboard interface was built on a large general-purpose IC board to provide room for other projects. The 14-pin socket just to the right of the white Beckman resistor network is for the ribbon-cable umbilical to the microcomputer.

inch-center, 2×6-position card edge connector (such as Amphenol 225-20621-101) which is a sadly bulky connector for an otherwise slim, trim component—I have considered soldering the ribbon cable directly to my keyboard. The keyboard can be mounted on a custom stand or its optional TASA stand or, as I prefer, can be used without a stand. If the board is placed directly on bare skin—say, on your bare legs—it will sometimes malfunction, but a layer or two of clothing will prevent this problem. Perhaps the only real shortcoming of

the keyboard is the lack of special-function keys. I would rather have had specific cursor-control keys than the parity (bit b_7) and parity-select (odd/even) features.

Conclusion

The interface circuits described above would work with almost any keyboard-to-microcomputer connection. They have given my TASA keyboard enough power to be the only front panel I use. I recommend the bleeper for any nondepressible-key

keyboard. For systems requiring more special-function keys (for cursor control, for example), the logic used here to detect a control-delete for system reset could be repeated. For systems with no +18 V dc conveniently available, the low (35 mA) current requirement and on-board regulator make it easy to construct either a small, unregulated stand-alone +18 V dc supply, or a small booster supply to place in series with a lower voltage supply.

Since I have little need for a caps-lock feature the interface doesn't include one. The articles written by Terry Conboy and Michael Dunlavey, listed in my references, describe simple circuits for caps-lock of ASCII keyboards. They could be activated/deactivated by control characters decoded like system reset in this interface. ■

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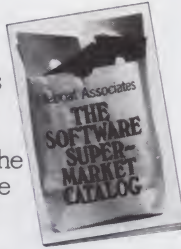
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Here's Where It's At

By Robert J. Roby

LOCATION		CONTENTS			
DECIMAL	HEX	BINARY		HEX	DECIMAL
4	0004	1100	0011	C3	195
8220	201C	1100	0011	C3	195
8221	201D	0010	0110	26	38
38	0026	1010	0001	A1	161
1000	03E8	0111	1110	7E	126
1001	03E9	0100	0101	45	69
1002	03EA	0111	1000	78	120
1003	03EB	0110	0001	61	97
1004	03EC	0110	1101	6D	109
1005	03ED	0111	0000	70	112
1006	03EE	0110	1100	6C	108
1007	03EF	0110	0101	65	101
1008	03F0	0010	0000	20	32
1009	03F1	0010	0001	21	33
Q					
READY					
Sample run.					

Often when working with BASIC, I want to examine the contents of a memory location. But due to the base 10 tyranny of BASIC, the PEEK and EXAM functions only display the data in decimal form. Machine-language monitors usually only show the data in hexadecimal, or perhaps ASCII (American Standard Code for Information Interchange, the character codes used by most terminals). And nothing ever shows the actual binary representation.

These displays are adequate if you have a conversion table handy, but if you are as lazy as I am you probably think the computer should do this kind of work for you. MEMLIST, written in North Star BASIC, might be the answer.

Once the program is running and the heading is printed, just type in the decimal memory address you want to display, followed by a carriage return. The computer then fills in the other five columns: the hex representation of the location and the contents in binary, hex, decimal and ASCII (see Sample run).

B	decimal byte address
B1	decimal contents of byte
D	temporary storage for decimal address
D1	temporary storage for decimal to hex conversion
I	loop index
J	loop index
L2	number of significant figures in hex address string
P	bit pointer for decimal to binary conversion
R	remainder in decimal to hex conversion
Z	top memory address + 1, used in overrange calculation
A\$	string storage for binary contents
B\$	input string for decimal address
H\$	string storage for hex output
H1\$	string used in decimal to hex conversion
L1\$	temporary string storage for hex address

Variable usage.

Robert J. Roby, 1209 Driftwood Drive, Euless, TX 76039.


```

100 REM MEMLIST 25 MAY 1980
110 REM THIS PROGRAM ACCEPTS DECIMAL MEMORY ADDRESSES
120 REM AS INPUT AND PRINTS THE CONTENTS IN
130 REM DECIMAL, HEX, BINARY AND ASCII.
140 REM THE PROGRAM IS WRITTEN IN NORTHSTAR BASIC.
150 REM FNB RETURNS THE VALUE OF THE PTH BIT OF
160 REM THE BYTE AT LOCATION B (1 OR 0).
170 DEF FNB(B,P)=INT(B/2^P)/2<>INT(INT(B/2^P)/2)
180 DIM H$(16)\H1$="0123456789ABCDEF"\Z=65536
190 REM SET UP OUTPUT HEADING
200 ! TAB(8),"LOCATION",TAB(40),"CONTENTS"
210 ! TAB(4),"DECIMAL",TAB(14),"HEX",TAB(27),"BINARY",
220 ! TAB(38),"HEX",TAB(46),"DECIMAL",TAB(58),"ASCII"
230 INPUT1 " ",B$\REM: GET ADDRESS IN STRING FORM
240 IF B$="Q" THEN END
250 IF B$="" THEN GOSUB 400 ELSE B=VAL(B$)
260 REM CORRECT FOR RANGE
270 FOR J=B TO Z STEP -Z\B=B-Z\NEXT
280 REM BUILD STRING CONTAINING BINARY EQUIVALENT OF BYTE
290 B1=EXAM(B)
300 FOR P=0 TO 7\A$(8-P,9-P)=STR$(FNB(B1,P))\NEXT
310 REM ROUTINE TO GET HEX ADDRESS AND HEX CONTENTS
320 D=B\GOSUB 410\L1$=H$\GOSUB 490\D=B1\GOSUB 410
330 REM PRINT OUTPUT LINE
340 ! TAB(14),L1$,TAB(25),A$(2,5)," ",A$(6,9),TAB(39),
350 ! H$,TAB(48),%3I,B1,TAB(60),
360 REM PRINT ASCII CONTENTS IF IT IS PRINTABLE CHARACTER
370 IF B1>32 AND B1<127 THEN ! CHR$(B1) ELSE !
380 GOTO 230\REM GO GET NEXT ADDRESS
390 REM ROUTINE TO HANDLE AUTO INCREMENT THROUGH MEMORY
400 B=B+1\B$=STR$(B)\! B$(2)\RETURN
410 REM H1$ MUST BE DIMENSIONED AND SET TO "0123456789ABCDEF"
420 REM BEFORE CALLING THIS DECIMAL TO HEX CONVERSION ROUTINE
430 H$=""
440 D1=INT(D/16)\R=D-D1*16\GOSUB 470
450 IF D1<16 THEN 460 ELSE D=D1\GOTO 440
460 R=D1
470 H$=H1$(R+1,R+1)+H$\RETURN
480 REM PAD HEX VALUE TO 4 CHARACTERS WITH LEADING ZEROS
490 L2=LEN(L1$)\FOR I=L2 TO 3\L1$="0"+L1$\NEXT\RETURN

```

Program listing.

It is often convenient to look at a consecutive series of locations. To do this, type in the first address of the series and wait for it to be displayed. For each consecutive address simply type a carriage return. MEMLIST

will automatically increment the address and display the contents. When you are through looking at memory, type a Q to exit the program.

The program output is formatted to fit on a 64-character screen. ■

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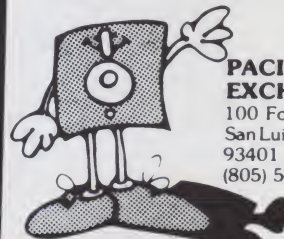
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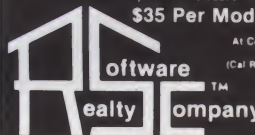
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Teach a Sorcerer New Tricks

By C. Kevin McCabe

The Exidy Sorcerer has a fairly extensive bag of tricks, but does lack a few features found in other BASIC interpreters. Two obvious shortcomings are the lack of a line renumbering capability and the inability to merge two or more taped programs into a single routine.

Although these abilities aren't part of the standard interpreter, they *can* be implemented. All it takes is an extra wave of the Sorcerer's wand, a few magic programming words and some knowledge of how BASIC programs are stored in memory.

Sorcerer's Microsoft 8K BASIC is not too different from the TRS-80 or PET versions. All program lines are stored in memory as ASCII character strings, with the lowest-numbered lines at the lowest memory addresses. Within the text of each stored program line, certain keywords—IF, FOR, GOTO and all the other commands and symbols in BASIC—are not spelled out. Instead, each such keyword is represented by a single-byte character, or token, having an unsigned integer value between 129 and 198 (80H and C6H).

The text of each full program line, which may include several statements separated by colons, is preceded by a four-byte header (Fig. 1). These four bytes specify the number of the current line, and a 16-bit address pointer to the beginning of the next full line's header. Both of these values are given in the form of a two-byte integer binary number. It's easy

to switch between integer binary and decimal values of line numbers or addresses:

Decimal value = low-order byte + (256 * high-order byte)

High-order byte = INT (decimal value / 256)

Low-order byte = decimal value - (256 * high-order byte)

Like most 16-bit values in memory, the low-order byte is stored in the first (lowest address) location, followed by the high-order byte. For example, if the header of the *next* full line starts at (decimal) address 500, the first two bytes of the *current* header would contain (decimal) 244 and 1. If the last two header bytes contain (decimal) 232 and 3, the number of the *current* line must be 1000.

At the end of each full program line stored in memory, following the final ASCII character, is a single byte with a zero value. BASIC uses this byte to identify the end of program lines while running or listing the program. The header for the next full line begins at the address immediately after the zero-valued byte, which—barring glitches—corresponds to the address pointer in the preceding header. This system of address pointers creates a "linked list," such as used for data base operations, although the "data" here is really program lines.

All BASIC programs begin at the same location in memory; the first byte of the first header is always located at decimal address 469 (01D5H). The end of the program is shown by an address pointer of 0000 in the final

header. No program text follows this special pointer.

RENUM

Now, let's use this information to create RENUM, a renumbering routine. It could be done in machine language—but writing machine language routines is not exactly the most thrilling way to spend an afternoon. In keeping with the KISS principle ("Keep It Simple, Stupid"), the renumbering routine can be written in BASIC. Sure, it will be slower—and as will be shown it will have some minor shortcomings—but a BASIC routine is certainly easier to write and debug!

Listing 1 shows the result. Both RENUM and the BASIC program to be renumbered must be in memory at the same time, as a single program (more about this later). A direct mode command of RUN 65000 begins execution. Since the routine being renumbered isn't being run, there's no problem if a variable name is duplicated in RENUM. If the program to be renumbered already has line numbers greater than or equal to 65000, though, you're out of luck.

Lines 65015–45 of RENUM ask for the lowest line number to be changed, that line's new number (which forms a "base" for the rest of the routine) and the increment to be added to

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each following line number. Lines 65050-85 skip through the entire program, using the information in one header to find the next and count the number of lines to be renumbered.

A renumbering routine must do more than change the line numbers in the headers, though. The program text also contains line numbers associated with GOSUB, GOTO and THEN statements. Once the values in the headers are changed, the RENUM must still be able to relate the new line numbers to the corresponding old numbers. The array LNS is used as a list of the original (decimal) line numbers that are to be changed by the routine. Lines 65090-130 fill the array and change the line number values found in the header areas.

The new line numbers are calculated simply, as the sum of the new "base" number plus the appropriate multiple of the increment between line numbers. It's no coincidence that the "appropriate multiple" for the increment is the same as the array location of the old line number. For example, assume line number 1459 is the fourth line in a program, and that the first program line's number is to be changed from 13 to 100, with an increment of 50 between lines. Line 1459 will be changed to 250 ($100 + 3 * 50$), and LNS(3) will contain the value 1459.

Now things become a bit more complicated—but still easier than machine language. Each program line may contain zero, one or more GOTO, GOSUB or THEN statements. The first two will always be followed by at least one line number reference, and by multiple references separated by commas in the case of ON-GOTO or ON-GOSUB statements. A THEN statement can be followed by a line number reference, a GOTO or GOSUB statement with a line number reference, or a non-referenced statement such as PRINT or STOP.

Remember that keywords such as GOTO or THEN aren't spelled out in memory; they use special single-byte tokens. A byte having a decimal value of 137 is a token for GOTO. The GOSUB token is a value of 141, and THEN is 162. Lines 65135-75 locate the zero-valued byte that immediately precedes a line's header, as well as the zero-valued byte that ends the line, and search for these three tokens within the line of program text.

When a token is found, lines 65180-200 check to see if the next non-blank

```

65000 REM--Function and variable initialization
65005 : DEF FNDEC(J) = PEEK(J) + 256 * PEEK(J+1)
65010 : CNT = 0: ZB = 468: LOWLN = FNDEC(ZB+3)
65015 REM--Operator input
65020 : INPUT "First change, change to, increment";FC,NLN,DELTA
65025 : IF FC <= NLN OR FC = LOWLN THEN 65045
65030 : PRINT "No, first value input must be less than second."
65035 : PRINT " if only part of program is to be renumbered."
65040 : PRINT "Try again, please!": PRINT: GOTO 65020
65045 : IF DELTA <= 0 THEN PRINT "Bad increment--": GOTO 65040
65050 REM--Count number of lines to change, & dimension array
65055 : NZB = FNDEC(ZB+1) - 1: CURLN = FNDEC(ZB+3)
65060 : IF CURLN = 65000 THEN 65075
65065 : IF CURLN >= FC THEN CNT = CNT + 1
65070 : ZB = NZB: HILN = CURLN: GOTO 65055
65075 : DIM LNS(CNT-1): PRINT: PRINT "Lines"; FC; "thru"; HILN;
65080 : PRINT "become lines"; NLN; "thru"; NLN + DELTA*(CNT - 1)
65085 : PRINT "A total of"; CNT; "line numbers changed."
65090 REM--Change line numbers in headers, & fill array
65095 : ZB = 468: J = 0
65100 : NZB = FNDEC(ZB+1) - 1: CURLN = FNDEC(ZB+3)
65105 : IF CURLN < FC THEN ZB = NZB: GOTO 65100
65110 : LNS(J) = CURLN: NWLN = NLN + J*DELTA: J = J + 1
65115 : POKE ZB+3, NWLN - 256*INT(NWLN/256)
65120 : POKE ZB+4, INT(NWLN/256): ZB = NZB
65125 : IF J < CNT THEN 65100
65130 : PRINT: PRINT "Header changes complete.": PRINT
65135 REM--Seek out "GOTO", "GOSUB", and "THEN" tokens
65140 : ZB = 468
65145 : ADR = ZB + 4: NZB = FNDEC(ZB+1) - 1
65150 : CURLN = FNDEC(ZB+3): IF CURLN < 65000 THEN 65160
65155 : PRINT: PRINT: PRINT "Routine completed.": END
65160 : PRINT: PRINT CURLN;
65165 : ADR = ADR + 1: CV = PEEK(ADR)
65170 : IF ADR >= NZB THEN ZB = NZB: GOTO 65145
65175 : IF CV <> 137 AND CV <> 141 AND CV <> 162 THEN 65165
65180 REM--Find line number reference, if any, after token
65185 : CMDADR = ADR: N$ = ""
65190 : ADR = ADR + 1: CV = PEEK(ADR): IF CV = 32 THEN 65190
65195 : IF CV = 137 OR CV = 141 THEN 65185
65200 : IF CV < 48 OR CV > 57 THEN 65165
65205 REM--Replace old line reference with new, if possible
65210 : N$ = N$ + RIGHT$(STR$(CV - 48),1)
65215 : ADR = ADR + 1: CV = PEEK(ADR)
65220 : IF CV >= 48 AND CV <= 57 THEN 65210
65225 : GOSUB 65235: IF CV = 44 THEN 65185
65230 : GOTO 65170
65235 REM--Subroutine--replace line reference with new number
65240 : N = VAL(N$): IF N < FC THEN RETURN
65245 : FOR J = 0 TO CNT - 1: IF LNS(J) = N THEN 65255
65250 : NEXT J: PRINT "Line #"; N; "is undefined.": RETURN
65255 : NWLN = NLN + J*DELTA: SPACE = ADR - CMDADR - 1
65260 : N$ = STR$(NWLN): N$ = RIGHT$(N$,LEN(N$) - 1)
65265 : IF LEN(N$) < SPACE THEN N$ = " " + N$: GOTO 65265
65270 : IF LEN(N$) = SPACE THEN 65285
65275 : PRINT "NOTE--operator must change": N; "to "; N$;
65280 : PRINT " in this line.": RETURN
65285 : FOR J = 1 TO SPACE: CV$ = MID$(N$,J,1)
65290 : CX = VAL(CV$) + 48: IF CV$ = " " THEN CX = 32
65295 : POKE CMDADR + J, CX: NEXT J: RETURN

```

Listing 1. The RENUM renumbering routine.

characters are a line number reference or another token (to cover the case of THEN GOTO or THEN GOSUB). If not, the search for tokens resumes.

Lines 65205-30 pull out the original reference following a token, digit-by-digit, and convert it to a string. The subroutine at lines 65235-95 will check the LNS array for the value found, and—most of the time—calculate the corresponding new value and poke it in memory following the token. The search then resumes for additional tokens, or other line number references separated by commas.

Most of the time? Well, yes—there

are two instances where the original value will not be changed. The first instance is when the reference is to an undefined line. If the original program statement is "GOTO 999" but no line 999 existed in the first place, there's obviously no way for RENUM to calculate a corresponding new line number. An advisory message is printed whenever such an undefined line reference is located.

The other instance is less obvious. Suppose the program statement "GOSUB 10" is to be renumbered, where the original line number 10 has been renumbered to line 1000. In memory, "GOSUB 10" takes up four bytes—

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for a token, a blank and the two digits—but "GOSUB1000" requires five bytes, even without a blank space between the token and the line reference. There's not enough room to insert the new number after the token.

The most obvious solution would be to shift the entire program one or two bytes forward in memory, but it won't work. The headers, remember, contain link pointers—addresses for following lines—which would be incorrect after such a shift. Adding an increment to each pointer is no good either, as that would require the renumbering routine itself to be changed while it is running.

In keeping with the KISS principle, RENUM takes the simplest approach. Whenever a new reference number won't fit the available space, the old number is left unchanged and a warning message is sent to the screen. The message specifies the new number of the affected line and both the old and new line references. At the completion of RENUM, sim-

ply key in a corrected line. A little care in writing original programs, with an extra space or two before line references, will do away with the need for such changes most of the time.

Other Shortcomings

Remember that both the renumbering routine and the program to be renumbered must be in memory at one time, combined as a single program. Using the renumberer as a development tool is simple enough; just load RENUM from tape first, then write the program as usual with line numbers below 65000. The program under development can be renumbered as many times as needed until completed; then the lines of RENUM can be deleted.

But what about existing programs? If a program to be renumbered is already in memory, a CLOAD RENUM will wipe it out. If RENUM is already in memory, loading the other program will wipe it out. That means

Listing 2. MERGE—machine-language routine to combine BASIC programs.

```

0000      ; MERGE
0000      ; BASIC PROGRAM COMBINER FOR THE SORCERER
0000      ; C. KEVIN MCCABE
0000      ;
0000      TOBAS EQU 00C0
0000      NBM EQU 00C2
0000      CURND EQU 00C4
0000      BOBAS EQU 00C6
0000      ACP EQU 00C8
0000      OFST EQU 00CA
0000      ERROR EQU 00D0
0000      END1 EQU 00E0
0000      END2 EQU 00F0
0000      WARM EQU 0E003
0000      SEND EQU 0E00C
0000      ; PART ONE--LOAD BASIC PROGRAM #1, THEN RUN
0000      ; THIS PART WITH MONITOR GO 0000
0000      LD HL,<0F00> ; SET UP STACK
0003      LD L,90
0005      LD SP,HL
0006      LD BC,0191 ; STACK SPACE
0009      OR A
000A      SBC HL,BL ; CALC. TOP OF
000C      LD <TOBAS>,HL ; FREE MEMORY
000F      CALL LBYTE ; FIND LAST BYTE OF
0012      ; BASIC PROGRAM #1
0012      LD BC,01D4 ; CALC. # OF BYTES
0015      OR A ; TO SHIFT
0016      SBC HL,BC
0018      LD <NBM>,HL
001B      LD BC,<NBM> ; SHIFT PROGRAM #1
001F      LD DE,<TOBAS> ; TO UPPER MEMORY
0023      LD HL,<CURND>
0026      LDDR
0028      INC DE
0029      LD <BOBAS>,DE
002D      LD HL,END1 ; SCREEN MESSAGE,
0030      LD B,0F ; THEN TO MONITOR
0032      JR NCHAR-$
0034      NOP
0035      ; PART TWO--LOAD BASIC PROGRAM #2, THEN RUN
0035      ; THIS PART WITH MONITOR GO 0035
0035      CALL LBYTE ; CALC. LAST BYTE OF
0038      ; BASIC PROGRAM #2
0038      OR A ; SUFFICIENT MEMORY?
0039      LD HL,<BOBAS>
003C      LD BC,<CURND>
0040      SBC HL,BC

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Listing 2 continued.

```

0042 38 55      JR    C,OVFLO-$      ; IF NOT, ABORT RUN
0044 2A C4 00   LD    HL,(CURND)     ; SET ADDRESS POINTER
0047 2B         DEC    HL            ; TO START OF FINAL
0048 22 C8 00   LD    <ACP>,HL      ; HEADER OF PROG #2
004B ED 4B C2 00 LD    BC,<NEM>      ; SHIFT PROGRAM #1 TO
004F 2A C6 00   LD    HL,<BOBAS>    ; DIRECTLY FOLLOW
0052 ED 5B C8 00 LD    DE,<ACP>     ; PROGRAM #2
0056 ED B0      LDIR
0058 2A C8 00   LD    HL,<ACP>      ; FIND OFFSET TO ADD
005B 01 D5 01   LD    BC,01D5      ; TO LINK POINTERS
005E B7         OR     A            ; OF PROGRAM #1
005F ED 42      SBC    HL,BC
0061 22 CA 00   LD    <OFST>,HL
0064 ED 5B CA 00 LD    DE,<OFST>
0068 2A C8 00   LD    HL,<ACP>      ; GET VALUE OF LINK
                                ; POINTER FROM
006B 4E         LD    C,<HL>        ; CURRENT HEADER
006C 23         INC    HL
006D 46         LD    B,<HL>
006E 3E 00      LD    A,0          ; IS THIS THE FINAL
0070 B8         CP    B            ; 0000 LINK POINTER?
0071 20 15      JR    NZ,PRUPD-$    ; NON-ZERO, SO JUMP
0073 B9         CP    C
0074 20 12      JR    NZ,PRUPD-$    ; NON-ZERO, SO JUMP
0076 23         INC    HL          ; ZERO LINK FOUND.
0077 23         INC    HL          ; SO UPDATE POINTERS
0078 22 B7 01   LD    <01B7>,HL    ; IN BASIC CONTROL
007B 22 B9 01   LD    <01B9>,HL    ; AREA
007E 22 BB 01   LD    <01BB>,HL
0081 21 F0 00   LD    HL,END2      ; SCREEN MESSAGE,
0084 06 04      LD    B,04         ; THEN TO MONITOR
0086 18 16      JR    NCHAR-$
0088 60         LD    H,B          ; UPDATE LINK POINTER
0089 69         LD    L,C          ; VALUE BY ADDING
008A 19         ADD    HL,DE       ; OFFSET VALUE
008B 44         LD    B,H
008C 4D         LD    C,L
008D 2A C8 00   LD    HL,<ACP>
0090 71         LD    <HL>,C
0091 23         INC    HL
0092 70         LD    <HL>,B
0093 ED 43 C8 00 LD    DE,<ACP>,BC  ; UPDATE ADDRESS OF
0097 18 CE      JR    LOOP2-$      ; CURRENT HEADER
0099           ; AND REPEAT LOOP
0099 21 D0 00   LD    HL,ERROR     ; SEND OVERFLOW
009C 06 0E      LD    B,0E         ; MESSAGE
009E 7E         LD    A,<HL>       ; SEND TO OUTPUT
009F CD 0C E0   CALL    SEND
00A2 23         INC    HL
00A3 05         DEC    B
00A4 20 F7      JR    NZ,NCHAR-$
00A6 C3 03 E0   JP    WARM        ; JUMP TO MONITOR
00A9 00         NOP
00AA 21 D5 01   LD    HL,01D5      ; SUBROUTINE TO GET
00AD 4E         LD    C,<HL>        ; ADDRESS OF LAST
00AE 23         INC    HL          ; BYTE OF A BASIC
00AF 46         LD    B,<HL>        ; PROGRAM'S FINAL
00B0 3E 00      LD    A,0          ; 0000 LINK POINTER
00B2 B8         CP    B
00B3 20 07      JR    NZ,UPDAT-$
00B5 B9         CP    C
00B6 20 04      JR    NZ,UPDAT-$
00B8 22 C4 00   LD    <CURND>,HL
00BB C9         RET
00BC C5         PUSH    BC
00BD E1         POP    HL
00BE 18 ED      JR    LOOP1-$
00C0           ; VARIABLES AREA
00C0 4F 56      DEFW    564F      ; 'OVERFLOW ABORT'
00C2 45 52      DEFW    5245
00C4 46 4C      DEFW    4C46
00C6 4F 57      DEFW    574F
00C8 20 41      DEFW    4120
00CA 42 4F      DEFW    4F42
00CC 52 54      DEFW    5452
00CE 00         NOP
00CF 00         NOP
00E0 50 50      DEFW    5050      ; 'PP + CLOAD NEXT'
00E2 20 2B      DEFW    2B20
00E4 20 43      DEFW    4320
00E6 4C 4F      DEFW    4F4C
00E8 41 44      DEFW    4441
00EA 20 4E      DEFW    4E20
00EC 45 58      DEFW    5845
00EE 54         DEFW    54
00EF 00         NOP
00F0 44 4F      DEFW    4F44      ; 'DONE'
00F2 4E 45      DEFW    454E

```

that the renumbering routine must be keyed in, line-by-line and character-by-character, each time it's needed.

Or does it? There is a better way, a way to load two or more BASIC programs from tape and combine them into a single, merged routine.

MERGE

MERGE (Listing 2) is a two-part machine-language routine to combine BASIC programs. MERGE may be used to add RENUM to an existing program or used to combine common library utility operations with an application program.

Remember that BASIC program lines are stored as strings of ASCII characters. The first four bytes of each line are a header, containing the line number of the current line, and a link pointer specifying the address of the next full line's header. The final header has a link pointer value of 0000, denoting the end of the program. A single byte, with a value of zero, separates the end of each line and the header of the following line (see Fig. 1). All BASIC programs begin at address 01D5H (469 decimal). The address of the final 0000 link pointer can be found by skipping through the program, header-by-header, and checking for a zero-value link pointer.

Fig. 2 shows the Sorcerer's memory allocations for a BASIC program. The address TIMEM denotes the top of installed memory (other than the ROM PAC space and video RAM, from C000H to FFFFH). For a 16K machine, TIMEM is 3FFFH; for 32K, 7FFFH is the top of user memory. The upper 111 bytes are reserved for the monitor's control memory. The monitor stack grows downward from below the control area.

Below the stack, BASIC dynamically allocates space for string and numeric variables and arrays, along with another stack and some free RAM. These areas "float" as the BASIC program is expanded or contracted, and also change during execution of the program. To keep track of the different areas, BASIC has its own program control memory at addresses 0100H through 01D4H. Address pointers to the start of the numeric variable storage area and the first and last bytes of the array area are placed in the control area, beginning at 01B7H, 01B9H and 01BBH, respectively.

BASIC expects to find these values in place prior to running or listing the

program; if not, the machine goes off on a tangent, requiring a reset and loss of the program in memory. The interpreter takes care of the task during normal additions or deletions from programs and after loading a program from tape.

Combining Programs

First, a BASIC program is keyed or

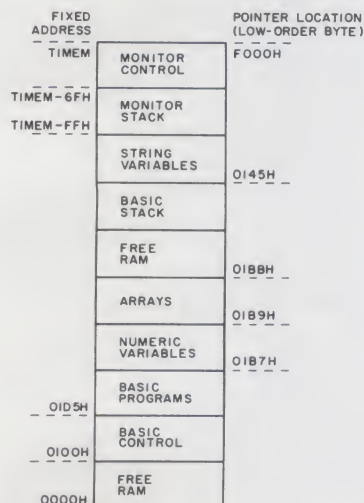


Fig. 1. BASIC program storage format.

loaded into memory in the usual way. Of the two or more programs to be merged, the first one *must* have the highest line numbers. The line numbers appearing in each program must be unique, and each must be greater than the highest line number in later programs to be added. The RENUM program starts with line 65000, so it can be used with virtually any other program to adjust line numbers as necessary.

Once the first BASIC program—let's call it HINUM—is in memory, the BYE command is used to exit to the monitor. The MERGE machine-language routine is loaded in, occupying the free space at addresses 0000H through 00FFH. The monitor command GO 0000 begins the first phase of MERGE.

MERGE determines the highest memory location that can be used, al-

lowing space for both the monitor stack and its control memory. To make the job easier, MERGE uses the helpful fact that the two-byte address of TIMEM is stored at F000H by the monitor.

The length of the program is determined much as in RENUM, by skipping through the program header-by-header and looking for a link pointer of 0000H. Once the size of the program has been found, the entire HINUM program is shifted as a block into a location higher in memory, just below the monitor stack area. BASIC can't do this, but a machine-language routine like MERGE can treat the stored program as just another bunch of bytes to be manipulated. At the end of the shift operation, a screen message tells the operator to exit the monitor and load the next BASIC program.

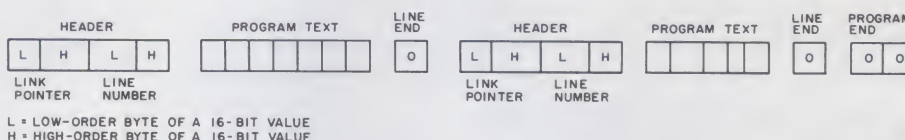


Fig. 2. BASIC memory map.

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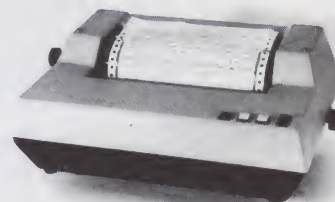


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The second program—call it LONUM—is read in using CLOAD. The original location of HINUM may be written over in whole or part, but it doesn't matter; there's still a copy of the program in upper memory, thanks to the shift. After LONUM is loaded, exit to the monitor once again. Start the second phase of MERGE with the monitor command GO 0035.

MERGE searches LONUM, locates its final 0000 link pointer and calculates the length of the program. If there isn't room in memory for both LONUM and HINUM, the routine terminates with an appropriate abort message. Given sufficient room, HINUM is shifted again, this time so that the first byte of its first header overlays the final 0000 link pointer of LONUM. The programs are now physically contiguous, but changes to HINUM's headers are needed for operational continuity.

Each of the link pointers in HINUM was based on a program starting address of 01D5H. Now, though, HINUM's first header is at a higher location, following all of LONUM. The problem is corrected by adding a constant offset value to each link

pointer in HINUM, up to the final 0000 pointer. Since MERGE had earlier calculated the length of LONUM, the offset value is already known.

The final step is to update the address pointers in BASIC's control area. All three pointers are set to the address two bytes after the final zero-value link pointer of HINUM. MERGE prints a final message and returns to the monitor.

The two programs are now fully combined, and will run as a single routine. Alternatively, MERGE can be used over and over to add other routines to the group. Each added routine, remember, must have lower line numbers than any part of the already-merged routines.

MERGE obviously isn't restricted to use with RENUM. Any two or more routines—subject to the line number restrictions—can be combined. A library of useful subroutines can be created, then added as necessary to other programs. The contents of such a library would vary according to need, but might include routines for graphics, data reduction or similar operations that are useful in more than one application. ■

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The Wonderful World Of Data Structures

By Phillip J. Windley

Most people view the computer from the perspective of the central processing unit and the functions it performs. There is, however, another important aspect of the computer that is commonly overlooked, especially by those familiar only with high-level programming languages such as BASIC and FORTRAN. That is the manipulation and storage of data in memory—data management.

High-level languages can implement underlying data management structures, but machine- and assembly-language programming determines their basic form.

Data Structures

Data structures form the basis of data management. They are collections of organized data that are in some way related; e.g., telephone books, encyclopedias and multiplication tables. The organization and characteristics of a data structure de-

pend on its function. Convenient access, sequential location, alphabetic storage and easy insertion and deletion of data are qualities we may require of a particular data structure. A filing cabinet, for example, is usually organized alphabetically for convenient access, and is built to allow insertions and deletions. A telephone book, while arranged alphabetically for easy access of data, makes alphabetical insertion of new names and numbers difficult.

Data structures significantly affect the size and speed of a given program. Harold S. Stone, in his book *Introduction to Computer Organization and Data Structures*, says that memory requirements for a program can vary by a factor of two to ten for different organizational representations of the same data. Processing speeds can vary by even larger factors. Choosing the correct data structure saves not only valuable memory

space (three cents a byte isn't cheap when you need another 4K), but also a lot of valuable time. Saving ten minutes on a long program is not at all impossible; if you run the program 100 times, that adds up to 16 hours and 40 minutes.

Probably one of the simplest data structures is the one-dimensional array. A one-dimensional array can be compared to a row of books on a shelf. Each book can be identified by its position on the shelf, fifth from the left end, for example. Books can be removed from or placed on the shelf randomly.

Arrays are implemented as consecutive lists in memory and, just as in the book example, each piece of data can be identified by a unique integer corresponding to its position in memory. This unique integer is called the subscript. Input to and output from the array can be completely random.

Implementing arrays in assembly-language programming is fairly straightforward. Set the array's upper and lower bounds and specify a base address at some point in memory prior to using the array. Storing and recalling data is then carried out by two subroutines, the subscript being passed to these subroutines as a parameter. Generalized flowcharts for an algorithm to store data (STORE(N)) and recall data (RECALL(N)) are shown in Fig. 1; N represents the subscript.

In both subroutines the subscript is compared with the upper and lower

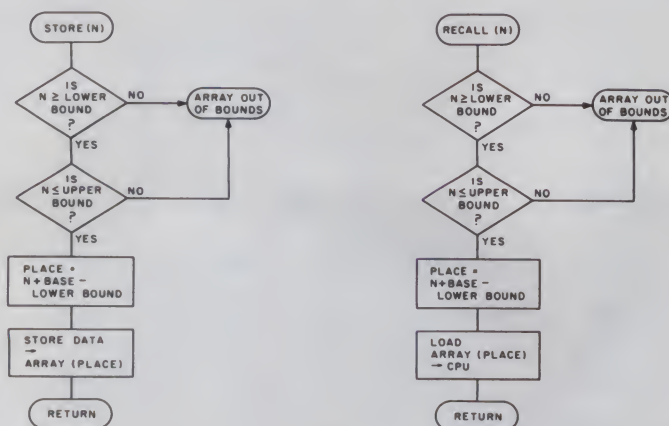


Fig. 1. Flowcharts for STORE(N) and RECALL(N).

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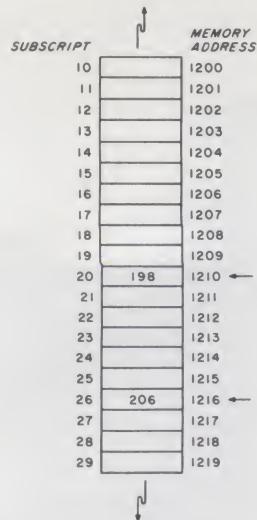


Fig. 2. Configuration of array in memory with examples of STORE and RECALL operations.

bounds of the program to prevent inadvertent damage to data already in memory. If N is greater than the upper bound or less than the lower bound, the array is out of bounds and you'll have to make adjustments. After the bounds have been checked, the address in memory is computed by adding N (the subscript) to the base address and subtracting the lower bound. The data is then stored to or recalled from that memory location.

As an example, say that the lower bound is 10 (all numbers are decimal values), the upper bound is 29 and the base address in memory is 1200. The upper and lower bounds define an array of 20 elements. If the subroutine $\text{STORE}(N)$ is called and the parameter $N=20$ and $\text{DATA}=198$ is passed to the subroutine, the computer would first compare the subscript 20 with the lower bound of 10 and the upper bound of 29, find the subscript in bounds and proceed to compute the address of element #20 in the array. It does that by adding the base address 1200 to the subscript 20 and subtracting the lower bound of 10. The result of this operation is 1210. The data, 198, is then stored in memory location 1210 through some form of indirect addressing. As shown in Fig. 2, this is indeed the correct location in memory.

Assume that data has previously been stored in element 26 and you wish to recall that data. When you call the subroutine $\text{RECALL}(N)$, the subscript 26 passes to the subroutine. The subroutine, finding 26 to be in bounds, calculates the address in

memory of element 26 by adding the base address 1200 to the subscript 26 and subtracting the lower bound 10. The result is 1216, and the data in that memory location is moved to the CPU.

Arrays have a number of uses; one common use of a one-dimensional array is to sort and reorder lists. The bubble sort makes good use of arrays and is an excellent programming example. If you aren't familiar with this sort, it is a good idea to look it over. It can be found in most introductory programming books.

You can also use arrays to store and recall data associated with a particular number. The population figures for the United States between the years 1960 and 1979, for example, can be stored in a one-dimensional array having a lower bound of 1960 and an upper bound of 1979.

Although arrays are handy for sorting ordered lists, they do have some limitations. Inserting data into the array, for instance, is difficult. Let's return to the bookshelf example. If you have a row of books on a shelf and you want to insert another book in the middle, the books already on the shelf must be shifted in some way. Shifting 100 pieces of data up or down one space in memory can be very time-consuming. Later I will describe a type of data structure called a linked list which solves this problem.

Stacks

Stacks are special one-dimensional arrays; rather than random input and random output, storage and retrieval are on a last in, first out basis (LIFO). This type of data structure is analogous to a stack of cafeteria trays; the last tray put onto the stack is the first one taken off. The operations associated with the stack are the POP instruction that pops data off the stack

and the PUSH instruction that pushes data onto the stack. In many microprocessors these are part of the instruction set; this makes the stack easy to implement. Even if this is the case, you should know how a stack operates so that you can use it more effectively.

Implementing stacks in assembly language is easy. A generalized flowchart for an array is shown in Fig. 3. In this program there are three values that must be defined before the subroutine is called. Those values are MAX, the highest address in memory used by the stack; MIN, the lowest value in memory used by the stack; and POINTER, the address of the last piece of data pushed onto the stack.

The pointer can either start at the top of the stack and work down the array, or it can start at the bottom and work up. You will notice that I chose to start at the top.

Look at the portion of the main program shown in Fig. 3a and you will see that POINTER is initialized equal to MAX + 1. To push data onto the stack, call the PUSH subroutine (Fig. 3b) and pass the data to be pushed as the only parameter. First the pointer is compared with the value of MIN. If it's less than or equal to MIN, the stack has reached its limits and no new data can be pushed onto the stack. If this is the case, the program will probably let you know that the stack is out of bounds.

If the POINTER is greater than the value of MIN, one is subtracted from the value of POINTER and the data is stored in the memory location addressed by the pointer. The computer then returns to the main program.

When the POP subroutine is called (see Fig. 3c), the pointer is checked to see if it is greater than the value of MAX. If it is, the stack has underflowed (i.e., popped more values

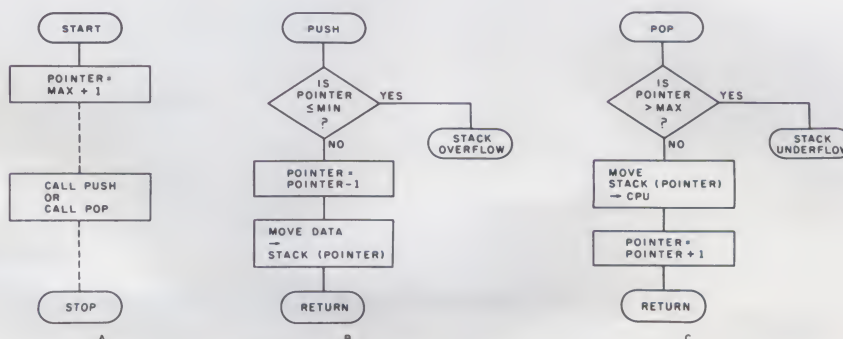


Fig. 3. (A) Main program calling PUSH or POP routine showing initialization. (B) PUSH routine. (C) POP routine.

than were pushed) and the program is in error. If not, the computer moves the data byte addressed by the pointer into the CPU. Following that, one is added to the pointer so that it points to the next byte of data in the stack, and the computer resumes execution of the main program.

As an example of program execution, assume that MAX has a value of 4019 and MIN has a value of 4000. During initialization, POINTER would be set to 4020, which is the value of MAX+1 (shown by the dotted arrow in Fig. 4a). When the subroutine PUSH is called, the value of POINTER is compared to the value of MIN. Since 4020 is greater than 4000, the program proceeds. One is

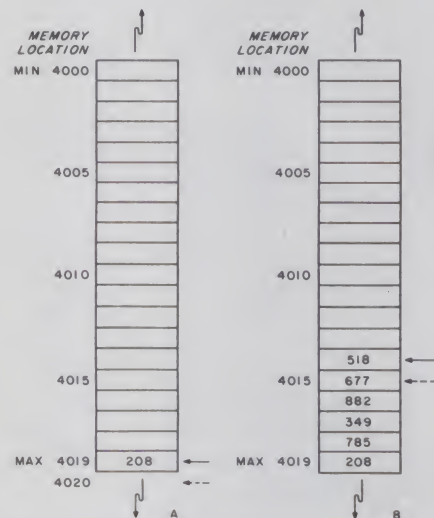


Fig. 4. Operation of a stack in memory. (A) Dotted arrow shows the position at initialization; solid arrow represents the pointer after a PUSH operation has been called. (B) Solid arrow represents the pointer at the end of the PUSH operation storing 518; dotted arrow is the position of the pointer after 518 has been POPPED.

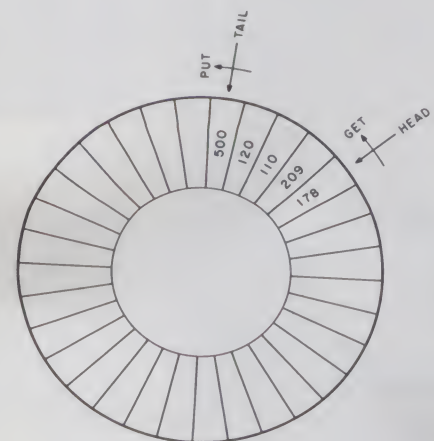


Fig. 5. Representation of a queue in memory showing the two pointers HEAD and TAIL.

subtracted from the pointer, giving a new value of 4019. The data to be PUSHED onto the stack, 200, is moved to memory location 4019, and the computer resumes execution of the main program.

Now, assume that five other numbers, 785, 349, 882, 677 and 518, have been pushed onto the stack. The value of POINTER is now 4014 (see Fig. 4b).

Let's look at the execution of the POP subroutine. When you call the POP subroutine, the value of POINTER (4014) is compared with the value of MAX (4019). Since 4014 is less than 4019, the data stored in memory location 4014 (518) is moved to the CPU and the value of POINTER is incremented so that its value is 4015. The pointer now points at the data that was stored immediately before 518, and the computer resumes execution of the main program.

Stacks are used extensively in assembly-language programming. They are very convenient for temporary storage of registers and for storing return addresses when subroutines are called. A stack is especially useful in servicing interrupts. When a peripheral device interrupts the CPU, the current operation is temporarily suspended and the CPU starts execution of a routine designed to service that particular device. Since the CPU was interrupted in the middle of an operation, the computer must store all the registers. Then, when the CPU has finished servicing the peripheral device, the computer can resume execution of the interrupted operation at the place it was suspended.

Queues

Stacks are good for quick, temporary storage of new data, but they have one quality that is not always desirable; the last byte of data stored is the first to be retrieved. In some programs you might want to temporarily store data and then recall it in the same order in which it was stored. To do this you could use a data structure called a queue.

Queues, like stacks, are special one-dimensional arrays, but instead of a last in, first out (LIFO) structure, the queue uses a first in, first out (FIFO) arrangement. A queue could be likened to a dixie cup dispenser—the first cup into the dispenser is the first one out. There is, however, one big difference; queues are usually written so that they seem to be cir-

cular, as shown in Fig. 5. The reason for this will become apparent.

Queues are a little more difficult to implement than one-dimensional arrays and stacks, but are still easy to understand. The operations performed by a queue are PUT and GET. To implement a queue, four values, MIN, MAX, HEAD and TAIL, must be defined in the main program. MIN represents the lowest address in memory of the array in which the queue is to be placed. Similarly, MAX represents the highest address of the array. TAIL and HEAD serve as the pointers and at initialization are set to the value of MIN.

When the subroutine PUT is called (refer to Fig. 6a), the value of TAIL is incremented and checked to see if it is in bounds. First, the value of TAIL is compared with the value of MAX. If it is greater, the value of TAIL is set to equal the value of MIN (this is what makes the queue circular). If TAIL is not greater than MAX (or, if it is, after it has been set to equal the value of MIN), TAIL is compared to the value of HEAD. If they are equal, the queue is full and the appropriate action is taken. If not, the byte of data is stored in the queue using the value of TAIL for an address. The computer then resumes execution of the main program.

The subroutine GET (Fig. 6b) operates in much the same manner as the PUT subroutine. The values of HEAD and TAIL are compared. If they are equal, the queue is empty and the program is in error; if not, one is added to the value of HEAD. Next, the value of HEAD is compared with the value of MAX. If HEAD is greater than MAX, HEAD is reset to the value of MIN (or if it is, after it has been reset to the value of MIN, the data in the memory location addressed by the value of HEAD is loaded into the CPU).

To better illustrate just how a queue works, draw out a set of memory locations as shown in Fig. 7 and label them 100-124. 100 is the value of MIN and 124 is the value of MAX. Take a pencil in your right hand and a pencil in your left hand. Call one of the pencils HEAD and the other TAIL; these will serve as pointers. Now, initialize your pointers to the value MIN by setting one down on each side of memory location 100 with the pencils pointing at it.

Try implementing the PUT routine shown in Fig. 6a. First, the value of TAIL is incremented by one, so move

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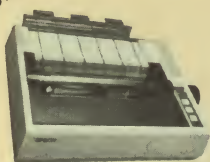
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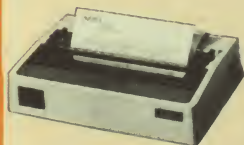
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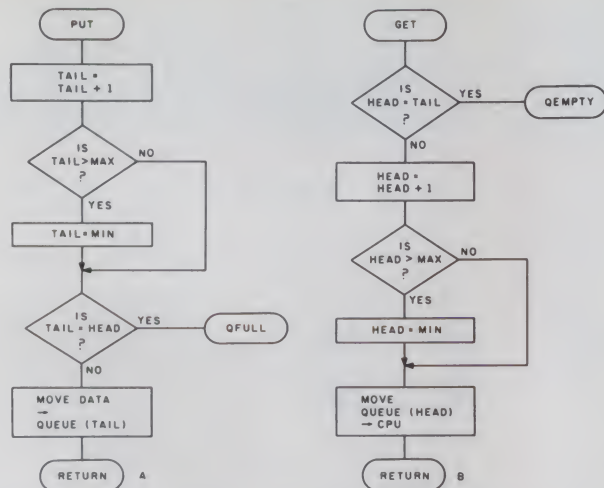


Fig. 6. (A) The PUT operation of a queue. (B) The GET operation of a queue.

the pencil representing TAIL to point at memory location 101. You, acting as the CPU, can see that 101 is not greater than the value of MAX (124), nor is it equal to the value of HEAD. Therefore, data can be stored in memory location 101 without any further processing.

Assume that this happens 23 more times without a GET routine having ever been called; your pencil should move down 23 spaces until it points at memory location 124, the value of MAX. Remember, as your pencil moved down the list, data was stored in each of those 23 locations.

If PUT is called again, without GET having been called, the following will happen. TAIL will be incremented so that it points to memory location 125.

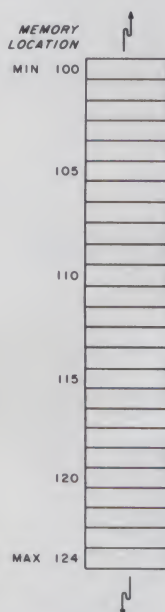


Fig. 7. Representation of memory for simulation of PUT and GET operations.

Since 125 is greater than the value of MAX, 124, TAIL will be reset to the value of MIN. (Move your pencil back to 100.) The pencil representing HEAD should still be there, and the computer (you) can see that HEAD and TAIL are equal, so it branches to the routine QFULL; no more PUT operations can be performed until a GET operation takes place.

Try running through some GET operations on your own. If you play around with this, you will find that your pencils can never pass each other—they only chase each other around the circle. When TAIL catches HEAD the queue is full, and when HEAD catches TAIL the queue is empty.

Queues are very useful in I/O operations. Often, when the CPU is interrupted it is not in a position to process the incoming data immediately. The data can be stored in a queue for subsequent processing. The reverse is also true. As the computer processes data to be output, it is often desirable to store the data in a queue and output it all at once, rather than output the data singly. This saves CPU time and also saves wear and tear on peripheral equipment such as disks, which are only engaged when involved in an actual I/O operation.

Advanced Data Structures

One-dimensional arrays, stacks and queues are simple but useful data structures. There are other, more complex data structures requiring programs of greater difficulty than those discussed so far. They are usually generalized cases of the data structures I have already outlined. A good understanding of arrays, stacks and queues aids the programmer

dealing with these more complex data structures, so I will touch lightly on them as an introduction but leave the actual programming to another time.

The first of these more advanced data structures may already be familiar—the multidimensional array. Remember that a one-dimensional array is implemented as a consecutive list in memory. A two-dimensional array is a set of one-dimensional arrays, the actual number of arrays being given by a second subscript. A two-dimensional array is somewhat like a chessboard, a set of eight rows of eight. Each space on the board can be described by a unique set of two integers. For instance, the set of integers (2,3) could describe the third space on the second row. A three-dimensional array is a set of two-dimensional arrays, with each space in the array being defined by a unique set of three integers. You can continue this as long as you want; the only limitation is the amount of memory space available.

Multidimensional arrays are useful in modeling the world around us because the world is multidimensional. Say, for example, that you wanted to write a program to take care of ticket reservations for a local theater. Since the seats have row and column numbers, you could set up a two-dimensional array and store information about each seat (occupied, unoccupied or unavailable) in the array. If the theater had a balcony, you might want to put the information in a three-dimensional array, since you have a set of two two-dimensional arrays.

There are many other uses for them. If you are an electronics buff, circuit analysis can entail working with matrices. Multidimensional arrays make matrices a snap!

Dequeues

Another type of data structure is the double-ended-queue or deque (pronounced "deck"). A deque is a hybrid version of a stack and a queue. In the queue we discussed earlier, the subroutine GET took data out of the queue at the pointer HEAD, and the subroutine PUT stored data at the pointer TAIL. In the deque, data can be put or got at either the HEAD or the TAIL. Four routines, PUTTAIL, GETTAIL, PUTHEAD and GETHEAD, are used. If you use only the routines GETTAIL and PUTTAIL, you can use the deque as a

stack. If you use only the routines PUTTAIL and GETHEAD, you can use the deque as a regular queue.

Dequeues are useful in specialized manipulations of data. They are also useful in saving memory space, because the same array space can be used as a queue or a stack, depending on the current needs of the program.

Linked List

The last type of data structure I will talk about is the linked list. Earlier, I mentioned that it was difficult to insert data into the middle of an array without shuffling a lot of things around in memory. A linked list solves this problem.

Linked lists are somewhat like the treasure hunts we used to play at as children. Each group of children is given a note with a clue to the location of the next clue. That clue, in turn, gives the location of the next clue. This continues until the treasure is found.

In linked lists there is no treasure, but the idea is the same. Associated with each byte of data is the address of the next byte in the list. Because of this, linked lists don't have to occupy consecutive locations in memory. To insert a byte of data into the list, the address portion of the data byte preceding the new data is modified to point to the new data byte, and the address of the data byte following the new data is written into the address portion of the new data. To delete data, the procedure is reversed.

I think you can see, however, that linked lists do require quite a bit more memory space to store the addresses. Linked lists are used in handling text, sorting lists and other tasks where data must be inserted and deleted often.

Conclusion

These are just a few of the data structures being used in computer programming today; there are many more. This brief introduction should serve to get you started. Many books have been written on the subject and can give you a more detailed explanation of the structures I have talked about, as well as explanations of many more I haven't.

Familiarity with data structures is important if you want to become more efficient in your programming techniques. Put them to work, and they will save you a lot of memory for program luxuries and a lot of time so that you can enjoy them. ■

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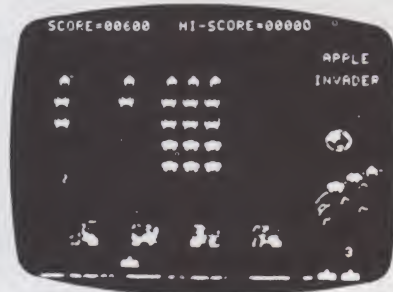
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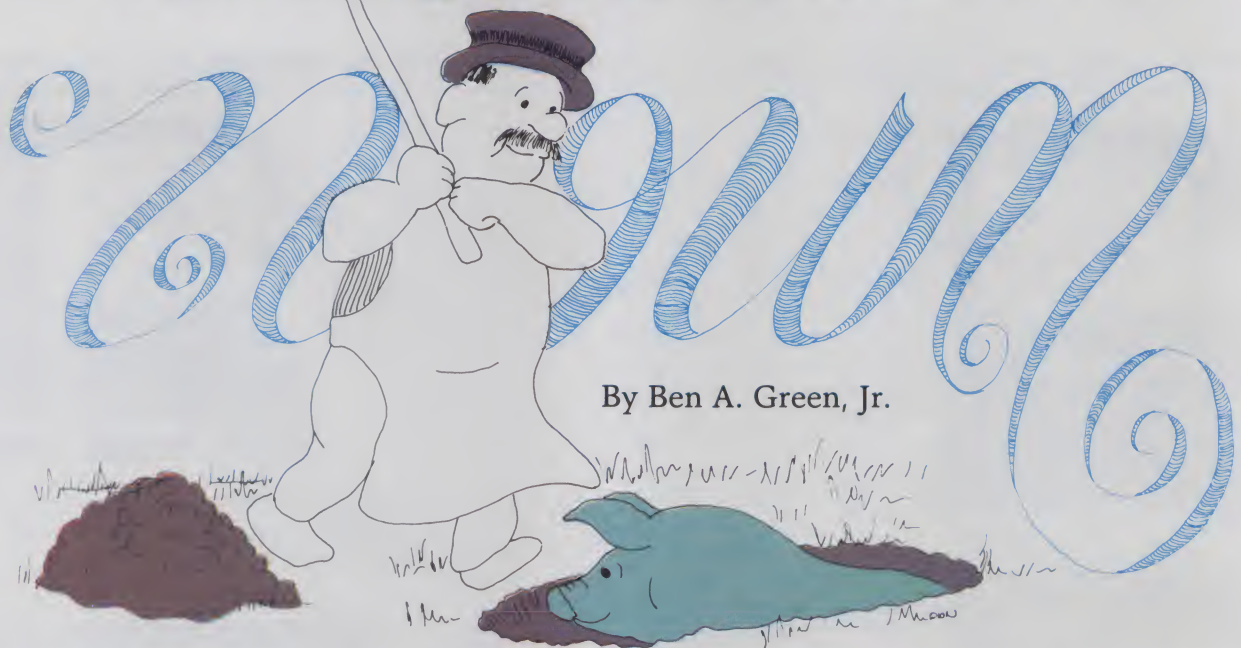
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Once upon a Time



By Ben A. Green, Jr.

Once upon a time, a helpful butcher dug up a green hog."

"Once upon a time, a thrifty fakir ignored a tortoise that hit a sour crooner."

"Once upon a time, a handsome pelican bribed a royal fakir that dug up a kind burglar that a pretty king that embraced a nanny beside a cowardly tortoise was bugging."

I didn't make these up; my PET did, using the program Fable described in this article. When the program was finally finished, my family and I spent all afternoon laughing ourselves silly over the output, so I thought you *Microcomputing* readers might enjoy it, too.

The idea for Fable came from Douglas Hofstadter's marvelous

book *Goedel, Escher, Bach* (Basic Books, 1979), a deep, funny, stimulating study of artificial intelligence. One of its central concepts is the recursive process, whose execution involves itself as a part. In computer applications an example is a subroutine that calls itself.

A subroutine that calls itself might never end; it might be caught in an endless loop. But if there is at least one possible control path through it that does not call the subroutine itself, it will terminate eventually, if the probability of taking the non-calling path is not zero.

To illustrate his idea, Hofstadter refers to a process called "fancy noun," which calls itself recursively, and "ornate noun," a simpler, nonrecursive process. Both are diagrammed in Fig. 1. Ornate noun has a straight-line control path that produces an article, an adjective and a noun, but it can also skip the article and either skip or repeat the adjective.

Fancy noun starts by calling ornate noun, but then takes one of three possible control paths: one that goes

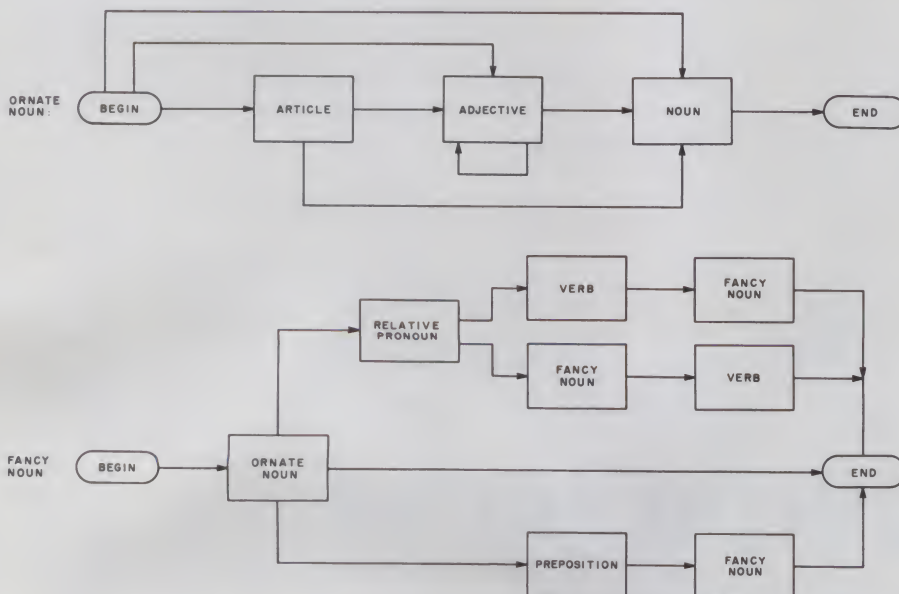


Fig. 1. Control paths for ornate noun and fancy noun.

Address correspondence to Ben A. Green, Jr., 2370 Algonquin Road, Schenectady, NY 12309.


```

100 REM=====FABLE=====
110 :
120 REM----READ DATA-----
130 :
140 N=30
150 DIM NOUN$(N),ADJ$(N),VERB$(N),PREP$
(5)
160 FORI=1TON:READ A$:NOUN$(I)=A$+" ":N
EXTI
170 FORI=1TON:READ A$:ADJ$(I)=A$+" ":NE
XTI
180 FORI=1TON:READ A$:VERB$(I)=A$+" ":N
EXTI
190 FORI=1TO5:READ A$:PREP$(I)=A$+" ":N
EXTI
200 DEF FNA(X)=INT(X*RND(1)+1)
210 :
220 REM=====MAIN PROGRAM=====
230 :
240 PRINT"ONCE UPON A TIME, ";
250 GOSUB330:REM:ORNATE NOUN
260 PRINT VERB$(FNA(N));
270 GOSUB420:REM:FANCY NOUN
280 PRINT".

290 PRINT"PRESS SPACE TO CONTINUE."
300 GET A$:IF A$="" THEN300
310 GOTO240:REM:REPEATS INDEFINITELY
320 :
330 REM---SUBROUTINE 'ORNATE NOUN'---
340 :
350 PRINT"A ";
360 IF RND(1)<.2 THEN390
370 :PRINT ADJ$(FNA(N));
380 :IF RND(1)<.05 THEN PRINT". ";
:GOTO370
390 PRINT NOUN$(FNA(N));
400 RETURN
410 :
420 REM---SUBROUTINE 'FANCY NOUN'----
430 :
440 GOSUB330:REM:ORNATE NOUN
450 ON FNA(4) GOTO480,510
460 RETURN
470 :
480 PRINT PREP$(FNA(5));
490 GOTO420:REM:RECURSION & EXIT

500 :
510 PRINT "THAT ";
520 IF RND(1)<.3 THEN560
530 :PRINT VERB$(FNA(N));
540 :GOTO420:REM:RECURSION & EXIT
550 :
560 GOSUB420:REM:RECURSION & RETURN
570 PRINT VERB$(FNA(N));
580 GOTO460
590 :
600 REM=====DATA=====
610 :
620 REM---NOUNS:-----
630 :
640 DATA BOY,CAT,COW,GIRL,HOG,JACKRABBIT,LADY,MOUSE,NANNY,POSSUM
650 DATA QUEEN,ROBOT,SINGER,TIGER,KING,BURGLAR,CROONER,DOG,FAKIR,GROCER
660 DATA POLICEMAN,SOLDIER,BAKER,BUTCHER,CONGRESSMAN,COOK,PELICAN,ROBIN
670 DATA "CANDIDATE FOR PRESIDENT",TORTOISE
680 REM---ADJECTIVES:-----
690 :
700 DATA RICH,GREEN,DINGY,FOUL,GEM-BEDED,HAPPY,KIND,LAZY,STINGY
710 DATA STRANGE,Pretty,POOR,MOROSE,DEAF,TACKY,VAIN,WICKED,YOUNG,CLUMSY
720 DATA COWARDLY,BRAVE,HANDSOME,ROYAL,SENILE,LOYAL,FRIENDLY,COURTEOUS
730 DATA HELPFUL,LIBERAL,CONSERVATIVE
740 :
750 REM----VERBS:-----
760 :
770 DATA BURNED,CRUMPLED,HIT,FOUND,"GOBBLED UP",HUNG,KILLED,LOVED,MET
780 DATA TICKLED,"WAS BUGGING",STABBED,"DUG UP",ATE,SHOT,GREETED,HUGGED
790 DATA SLAPPED,SAW,INSULTED,"SAT ON",SCRATCHED,KISSED,HATED
800 DATA"SPAT ON",EMBRACED,"JUMPED ON",CHEATED,BRIBED,GOOSED
810 :
820 REM----PREPOSITIONS:-----
830 :
840 DATA FOR,WITH,"BECAUSE OF","NEXT TO","BESIDE

```

Fable program.

straight through to the end, a low one that adds on a prepositional phrase or a high one that adds on a dependent clause like "that the boy hit" or "that hit the boy." But in place of simply "the boy," fancy noun calls for a fancy noun in that place. This also happens in the low path, where instead of merely "with a pelican," for example, the process calls for a fancy noun to put after "with." This feature makes fancy noun a recursive process. Each call to fancy noun will call upon fancy noun until the straight path is taken, which terminates the process.

The program Fable uses these two processes as subroutines (I modified ornate noun to make it always choose the article "a," which seemed most appropriate for a fable) to build a complete sentence beginning "Once upon a time." It uses the PET's random number function RND(1), which produces a decimal fraction between 0 and 1 with a uniform probability distribution, to make the choice of control path and of vocabulary whenever necessary. After loading the arrays with 30 nouns, adjectives and verbs and five prepositions, and defining a function to produce

random integers between 1 and X, it is ready to write fables. It starts with an ornate noun and a verb. Then it gets a fancy noun to serve as the object of the verb. That's it.

Lines 360 and 380 set the probabilities for skipping or repeating adjectives. The probabilities for the three branches of fancy noun are set in line 450: if FNA(4) returns 1, we get a prepositional phrase; with 2 we get a dependent clause; and with either 3 or 4 we simply fall through to line 460, which represents termination of the subroutine. (If you change line 450 to include FNA(2), then the sub-

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routine will never terminate and you will get a sentence that never ends.) In the "that" branch, the choice between "that hit the boy" and "that the boy hit" is made in line 520.

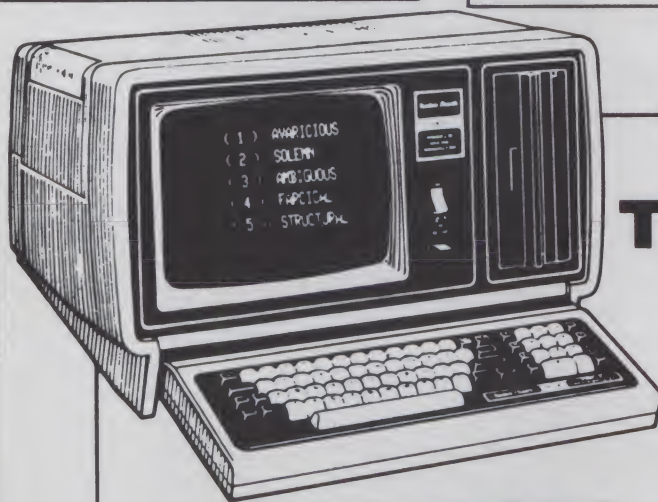
You can, of course, substitute your own vocabulary; some of the examples I have quoted were produced from earlier versions. It might be interesting also to fix the program so that it will not repeat a noun.

The sentences can get complicated. For a while I was stumped by "Once upon a time, a trustworthy queen found a loyal butcher that gobbled up a sour jackrabbit that a dingy tiger that a young policeman that fixed a vain mouse that scratched a morose tiger over a trustworthy grocer was seeing crumpled." Eventually, I figured out that it was the policeman who was seeing the dingy tiger, who, in turn, was the one who crumpled the rabbit.

My favorite fable, though—one that has a lot to teach us—is the following:

"Once upon a time, a brave king hit a clumsy soldier with a deaf, stingy, dingy jackrabbit."

I'm still wondering why. ■



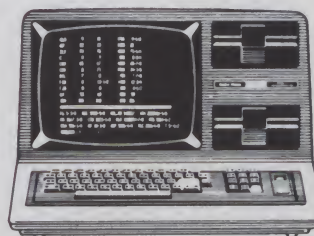
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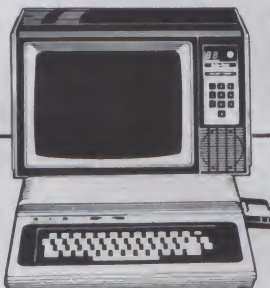
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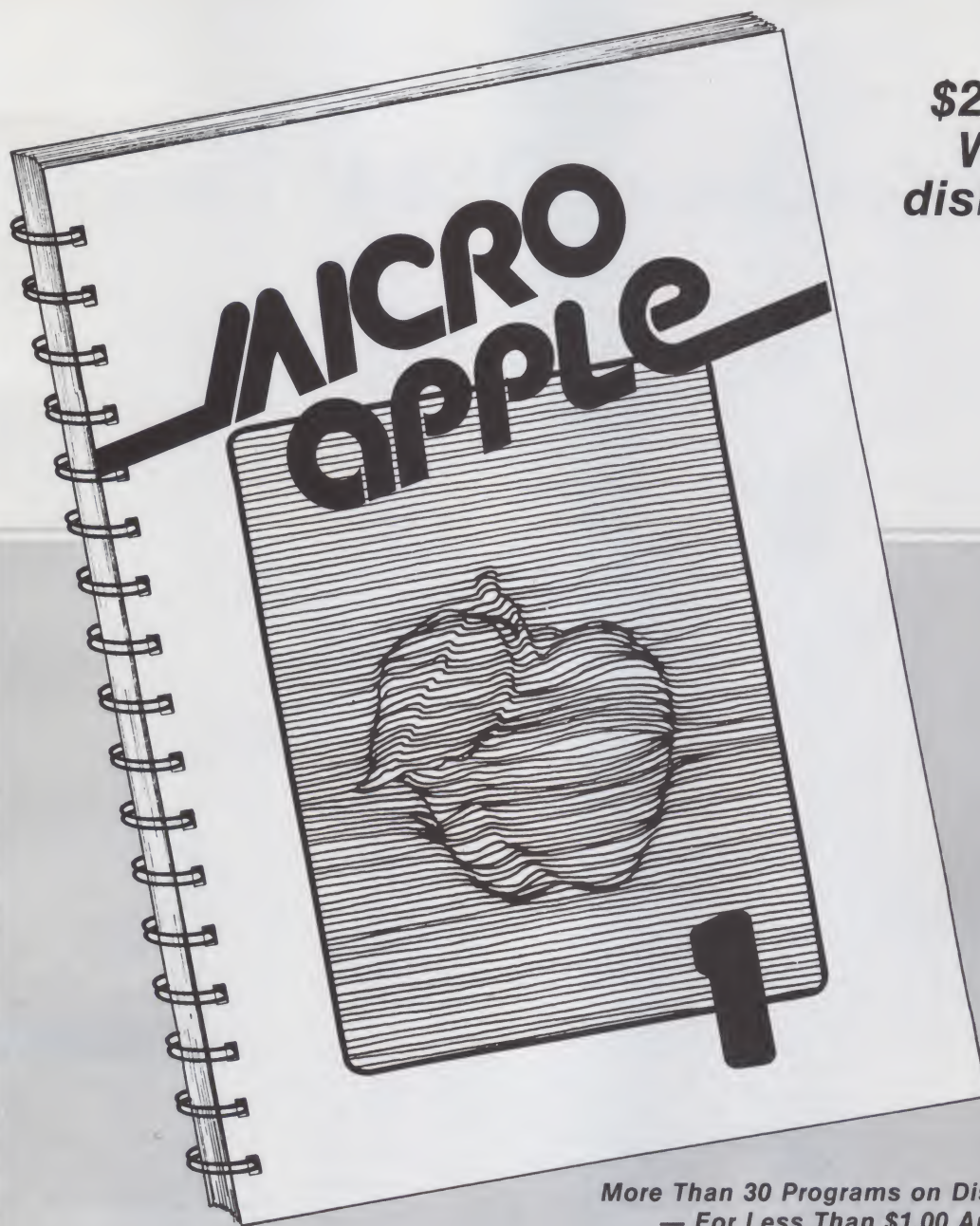
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Double-Good OSI Protection

By Geoff A. Cohen

This circuit eliminates accidental operation of the break key on my OSI C1. The key has to be pressed *twice* within one second.

I installed an LED in the break key, in a similar fashion to the shift lock on DEC machines (see Fig. 1). Note that this device is placed in series

with the line between the break key and the computer reset pin (6502 pin number 40).

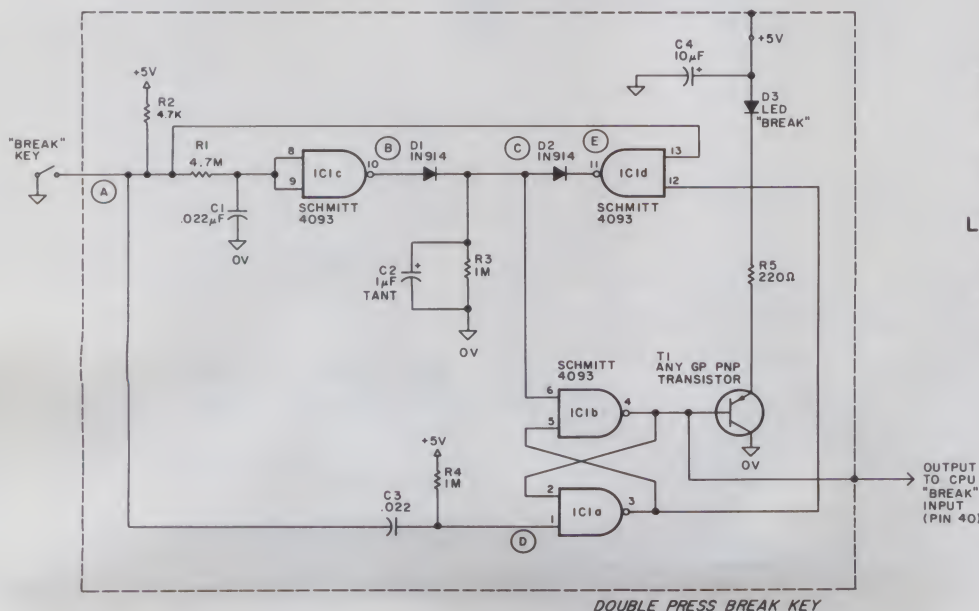
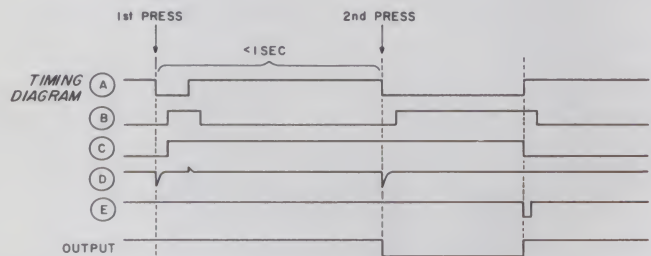
Circuit Operation

When the break key is first pressed, the output of IC1c goes high after 100 ms delay ($R1 + C1$), charging the one second timeout capacitor ($C2$) via diode D1. This allows the RS flip-flop (IC1a + b) to be triggered by an input pulse to pin 1.

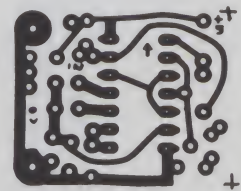
If the break key is pressed again within one second of the first press, a short (20 ms) negative pulse (via $R4 + C3$) sets the RS flip-flop (IC1a + b) output to low. The output will stay low as long as the break key is pressed. When the break key is released, IC1d will discharge the timeout capacitor ($C2$) through diode D2.

The device is now ready for the sequence to be repeated when the break key is again pressed. ■

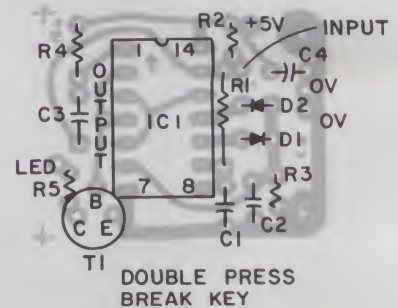
Address correspondence to Geoff A. Cohen, 72 Spofforth St., Holt, A.C.T. 2615, Australia.



Circuit and timing diagram.



PC board layout.



Component layout.

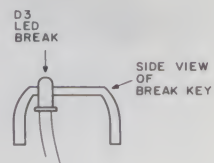


Fig. 1.

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To and Fro with Apple's Inverted Decimal Code

By Don Lancaster

The Apple II, like many other microcomputers, has two ways of calling out locations in its address space.

If you are using assembly or machine language, the 65536 locations in the address space are called out with a hexadecimal code, ranging from 0000 to FFFF.

If you are using Integer BASIC or another higher-level language, these same address locations are called out as a decimal number, ranging from -32768 to +32767. Decimal numbers are more useful in BASIC because they eliminate the strings you might have to use for the hex A, B, C, D, E and F values that stand for decimal 10 through 15.

The obvious thing to do is to let each decimal location be the same numeric equivalent of each hex location. But this would take numbers that go from 0 to 65535, and Apple's Integer BASIC only allows numbers from -32767 to +32767.

To beat this problem, the Apple people invented an inverted decimal code. It uses the bottom half of the memory as direct numeric equivalents and the top half of the memory as upside down decimal negative values. This is roughly akin to Apple II's

complement notation, where some of the numbers seem to be heading the wrong way at first glance. Fig. 1 shows two ways the Apple address space is mapped.

For locations hex 0 to 7FFF, the decimal code is the same as its hex value. Decimal 0 to +32767 goes with hex 0 to 7FFF. For locations hex 8001 through FFFF, the decimal code counts backwards, and with a minus sign. This way, hex FFFF is decimal -1; hex FFFE is decimal -2. The down counting continues to -32767 at hex 8002, and finally -32767 at hex 8001.

Location hex 8000 is complex. I'll return to it later. It is coded as decimal -32768, but you can't get there from here without using some tricks.

Why Convert?

Why would you ever have to worry about these two codes? Any time you write a BASIC program, if you want to turn loose the full power of the monitor, you have to use the inverted

decimal code to call whatever it is you are after. If you want to change or look at a memory location in your machine, you also have the PEEK and POKE commands, also called as decimal numbers.

Some locations and sequences may make much more sense or appear more regular in hex than in inverted decimal. The screen locations for color graphics, hi-res graphics and the alphanumeric characters are much simpler to understand and much more "logical" in hex notation than in inverted decimal. So switching the coding can sometimes give you insight into what is happening, or point to a newer or better way of doing things.

Finally, if you are studying someone else's BASIC program and see a mysterious CALL 1002, how can you tell what it means? Only with a back and forth conversion can you find out

```
CALL (-32767-1)
PRINT PEEK (-32767-1)
```

Table 1. Location hex 8000 is defined as inverted decimal -32768. Here are two ways to get there without an error message.

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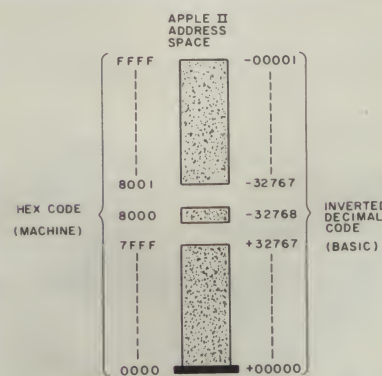


Fig. 1. Two ways of mapping Apple's address space—hex for machine language and inverted decimal for BASIC.

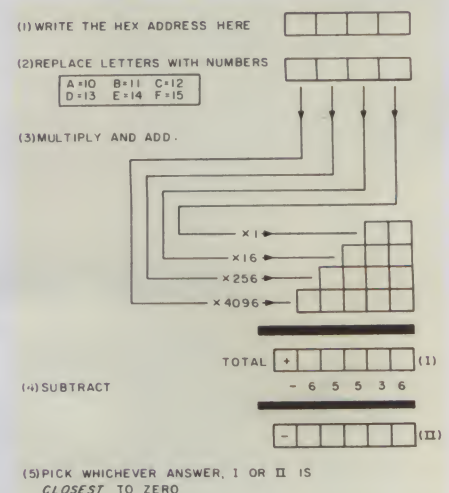


Fig. 2. Worksheet to convert hex locations to inverted decimal locations.

what the program is really up to.

For some reason, people avoid trying to convert between these two codes. Sometimes you can cheat by finding a code equivalent that may be nearby, and then counting down or up in the right direction. But, that's no fun, particularly if you go the wrong way and bomb the machine. And this avoids learning to do things the right way in the first place.

You can also generate a list and look up all the values in either direction. But this takes 65536 double entries and will produce a bunch of computer printouts. There is something better.

Scratchpad Conversions

You can look at four ways of getting from hex to inverted decimal and back again. The worksheet methods let you use a calculator and a sheet of paper. This is convenient if your Ap-

ple isn't up, or if you don't want to change what is in it, or if you just have a single location or two to convert.

Fig. 2 shows a worksheet to convert hex locations to inverted decimal locations. You can put another pad of paper along the right margin of the worksheet and work in parallel, using the same worksheet over and over again.

You use this worksheet by writing the hex address at the top and then replacing the letters with their decimal 10 through 15 equivalents. You then go through the multiply-and-add song-and-dance shown, scaling the digits by 1, 16, 256 and 4096. Total I in the figure is a direct decimal conversion of the hex address space. In other machines, this may be all you need.

But, for the Apple, you have to invert the decimal code for everything in the top half of memory. To do this, you subtract 65536 to get a new answer, II. You then pick answer I or II, the one nearest zero, as the correct conversion. Addresses 0000 to 7FFF will convert directly, while 8001 through FFFF will convert to the down-counting negative decimal values.

Fig. 3 shows two sample calculations. Here you prove that the Apple memory location "turn on the hi-res graphics" hex C057 is decimal -16297 (Fig. 3a). A second example

(1) WRITE THE HEX ADDRESS HERE

C	0	5	7
---	---	---	---

(2) REPLACE LETTERS WITH NUMBERS

A=10	B=11	C=12
D=13	E=14	F=15

12	0	5	7
----	---	---	---

(3) MULTIPLY AND ADD:

x1	0	7			
x16	0	8	0		
x256	0	0	0		
x4096	4	9	1	5	2

TOTAL

+	4	9	2	3	5
---	---	---	---	---	---

 (I)

(4) SUBTRACT

-	6	5	5	3	6
---	---	---	---	---	---

-	1	6	2	9	7
---	---	---	---	---	---

 (II)

(5) PICK WHICHEVER ANSWER, I OR II IS CLOSEST TO ZERO

Fig. 3a. Two examples converting hex to inverted decimal.

(1) WRITE THE HEX ADDRESS HERE

0	4	2	7
---	---	---	---

(2) REPLACE LETTERS WITH NUMBERS

A=10	B=11	C=12
D=13	E=14	F=15

0	4	2	7
---	---	---	---

(3) MULTIPLY AND ADD:

x1	0	7		
x16	0	3	2	
x256	1	0	2	4
x4096	0	0	0	0

TOTAL

+	0	1	0	6	3
---	---	---	---	---	---

 (I)

(4) SUBTRACT

-	6	5	5	3	6
---	---	---	---	---	---

-	6	4	4	7	3
---	---	---	---	---	---

 (II)

(5) PICK WHICHEVER ANSWER, I OR II IS CLOSEST TO ZERO

Fig. 3b. (Second example.)

+- SIGN GOES HERE

6	5	5	3	6
---	---	---	---	---

(A) WRITE THE DECIMAL ADDRESS HERE

--	--	--	--	--

(B) IF (A) IS +, REWRITE IT HERE
 IF (A) IS -, DO THE SUBTRACTION AND PUT RESULT HERE

(C) DO THE DIVISIONS SHOWN BUT PUT ONLY WHOLE NUMBER RESULTS IN THE BOXES

$\div 4096 = \frac{H4}{4} \times 4096 =$

--	--	--	--

SUBTRACT AND PUT REMAINDER HERE

--	--	--	--

$\div 256 = \frac{H3}{4} \times 256 =$

--	--	--	--

SUBTRACT AND PUT REMAINDER HERE

--	--	--	--

$\div 16 = \frac{H2}{4} \times 16 =$

--	--	--	--

SUBTRACT AND PUT REMAINDER HERE

--	--	--	--

(D) REWRITE H1 TO H4 HERE. SUBSTITUTE LETTERS A-F FOR DECIMAL 10 TO 16

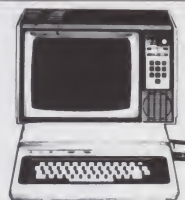
A=10	B=11	C=12
D=13	E=14	F=15

HEX

H4	H3	H2	H1
----	----	----	----

Fig. 4. Worksheet to convert decimal locations to hex locations.

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(Fig. 3b) shows that the upper right-hand character on the screen is both hex 0427 and decimal 1063.

Fig. 4 gives you a new worksheet to go the other way—from inverted decimal to hex. Here, you write the decimal address at the top. If the decimal address is positive, you do nothing to it. If the decimal address is negative, you subtract the address from 65536. Either way, you get a positive number from 0 to 32767.

You then go through a funny game called a math iteration. You try dividing by 4096 and write only the whole number result (the part of the answer to the left of the decimal point on your calculator) in box H4. Now, you multiply back only the whole number part of H4 and subtract to get a remainder.

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Repeat this process for 256, 16 and finally 1. Each time, use only whole numbers. This gives you your raw hex digits. Finally, put all your H1 to H4 digits in order and replace the numbers above 9 with their A-F equivalents.

Two examples in Fig. 5 show the Apple locations that toggle the speaker and switch the screen from normal to inverse mode.

Conversion Programs

Listing 1 shows you a program to convert from hex to inverted decimal code. Steps 100-130 do some housework for you, clearing the screen and asking you to input the hex address. This address is read as a string (remember those letters!) called HEX\$. You then read each piece of the string in steps 140-170. If you have a letter, step 170 changes the letter to its numeric 10-15 equal.

In step 190, test to see if you are working on the top half of memory. If you are, subroutine 400-420 complements the hex code for you and decides to print a minus sign in front of your final answer. If you are on the bottom half of memory, skip this step.

Then calculate the decimal equivalent in step 200 and print the answer in 210. Steps 220 and 230 do some formatting and repeating.

You can test this program with any of the previous examples. After your

first answer, hit the carriage return to enter your next conversion. Do this till all the numbers you need are converted.

The reverse program trip of inverted decimal to hex is shown in Listing 2. It is somewhat longer and takes a fancier string. Again, start with housework in steps 100-130. Step 140 erases a question mark that messes up the display and starts you off assuming a lower half conversion. If you are working on the top half of the address space, step 150 goes to subroutine 400-410 to do repair work.

Step 160 sets up the string that will automatically convert numbers 10 to 15 to their hex letters. Lines 190 through 220 execute the conversion iteration; step 240 adds 8 to the left-most hex digit if you started out with a negative inverted decimal number. Lines 250-260 print out your answer, while 270 and 280 close the loop to let you repeat.

Operation is about the same as the earlier program. Type RUN and enter the code to be converted. The answer appears. Then use a carriage return to start entering a new number. CTRL C ends the program and returns you to Integer BASIC.

You might like to test this program to prove that step 140 does, in fact, erase a question mark on the screen.

Which Way?

Pick the worksheet methods if you

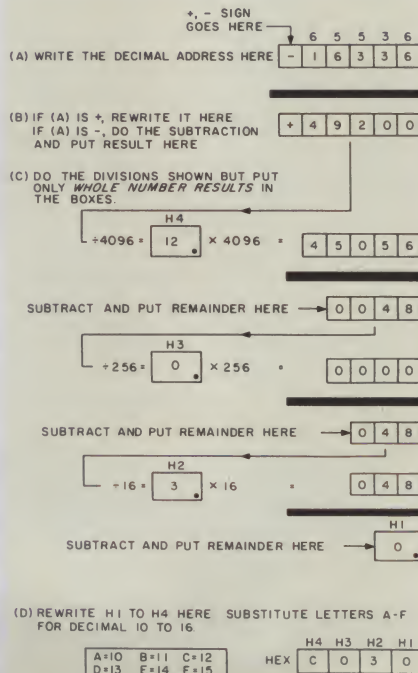


Fig. 5a. Two examples converting inverted decimal to hex.

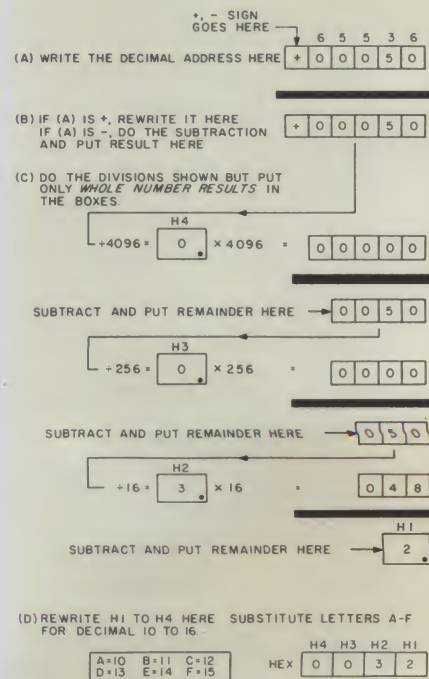


Fig. 5b. (Second example.)

have only a couple of conversions, or are away from your computer. Use the programs for everything else. You might like to combine both programs into one that goes either way. You can also use trial and error to let one program do the backwards trip for you.

The Hex 8000 Problem

Location hex 8000 looks confusing. The Apple people call this decimal -32768, but, if you try getting directly at 8000, you will probably get ">32767 ERR". Fortunately, location 8000 rarely needs code conversion.

But there is a way. It is sneaky, but it works. Apple allows a value of -32768 *inside* the machine. It just doesn't let you put this number into

the machine or take it back out any direct way.

Table 1 shows ways to get at this location. You have to give the Apple something to do that will make it internally compute a value of -32768. For instance, PEEK (-32767-1) will also work without an error message. Should you have some machine-language routine at 8000, CALL (-32767-1) will also work without an error message.

So, don't be afraid of those funny number games involved in getting from hex to inverted decimal and back again. These codes are simple and easy to use. The two codes and their conversion are versatile tools when you learn to convert them quickly. ■

```
100 REM * APPLE HEX TO DECIMAL
110 DIM HEX$(4),A(4)
120 CALL -936:VTAB 6: TAB 10
130 INPUT "HEX ADDRESS ",HEX$
140 FOR N=1 TO 4
150 A(N)=ASC(HEX$(N,N))
160 A(N)=A(N)-176
170 IF A(N)>15 THEN A(N)=A(N)-7
180 NEXT N:HEX$=""
190 IF A(1)>7 THEN GOSUB 400
200 DECIMAL=A(1)*4096+A(2)*256+A(3)*16+A(4)
210 PRINT: TAB 10: PRINT "IS DECIMAL ";: PRINT HEX$;: PRINT DECIMAL
220 PRINT: PRINT: PRINT: PRINT: PRINT
230 INPUT HEX$: GOTO 120
400 FOR N=1 TO 4:A(N)=15-A(N): NEXT N
410 A(4)=A(4)+1
420 HEX$="" -: RETURN
```

Listing 1. Program for hex to inverted decimal conversion.

```
100 REM : APPLE DECIMAL TO HEX
110 DIM HEX$(16),A(4)
120 CALL -936:VTAB 6: TAB 10
130 INPUT "DECIMAL ADDRESS ",DECIMAL
140 POKE 1689,160:FIX=0
150 IF SGN (DECIMAL)<0 THEN GOSUB 400
160 HEX$=""0123456789ABCDEF"
170 A(1)=DECIMAL/4096+1
180 R=DECIMAL MOD 4096
190 A(2)=R/256+1
200 R=R MOD 256
210 A(3)=R/16+1
220 A(4)=R MOD 16+1
230 PRINT: TAB 13: PRINT "IS HEX ";
240 IF FIX=1 THEN A(1)=A(1)+8
250 FOR N=1 TO 4
260 PRINT HEX$(A(N),A(N));
270 NEXT N: PRINT: PRINT: PRINT
280 INPUT HEX$: GOTO 120
400 DECIMAL=32767+DECIMAL+1:FIX=1
410 RETURN
```

Listing 2. Program for inverted decimal to hex conversion.

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Poking the Apple's Screen

By Patrick C. Moyer

The BASIC print command does not always provide the flexibility that a programmer needs. One alternative is a technique that uses the POKE command to display information on the screen.

This technique requires you to access and modify the computer's video display or screen buffer. The buffer is that portion of the computer's memory which holds a copy of all the information currently on display. Modifying this area lets you print any character at any location on the screen without affecting any other character that is on the same line.

This article describes the technique as applied to the Apple II computer. Therefore, it is not applicable to graphics, but is relatively easy to apply to text display.

Screen Buffer

The first step is to locate the screen buffer in memory. This is done using a memory map, which, for the Apple II, can be found on page 126 of the Applesoft reference manual. It indicates that the screen memory is located at hexadecimal addresses 400-7FF.

Since this area of memory will be accessed using the BASIC POKE command, you must convert these addresses to decimal. Thus, the decimal numbers 1024-2047 will be used in the POKES. A quick subtraction reveals that there are 1024 memory locations (40 characters on 24 lines).

The Apple II screen buffer is not organized as a continuous memory area but as eight 128-byte segments (Table 1). Each segment contains 120 bytes of memory which correspond to 120 print positions on the Apple screen, followed by eight additional bytes. Each segment contains three 40-character (bytes) lines of data. These lines do not appear consecutively on the screen.

The screen is broken into three divisions (Table 2). Each segment of memory contains one line from each division. The first segment contains memory locations for lines 1, 9, 17; the second segment lines 2, 10, 18; and so on. The first 40 bytes correspond to locations from left to right on the first line (addresses 1024-1063), the next 40 are for print positions on the eighth line and the last 40

bytes for characters on line 17. To print a character on the screen you must know the segment the line appears in and the tab position to find the exact address to poke.

To simplify this process use Table 2. This worksheet has the address for the beginning and end of each line in the left and right margins, and a scale from 0-39 across the top and bottom which indicates each print position. By adding or subtracting this amount to the margin address, any position on the Apple screen can be located.

For example, if a character is to be placed at line 10 and tab position 10, the procedure is:

1. Look down the left side of the worksheet and find line 10 and the associated address: 1192.

2. Count over 10 spaces and read the scale: 9.

3. Add the address to the scale number to obtain the location to be poked: $1192 + 9 = 1201$

This is the procedure to locate any positions on the Apple screen. This position is the first parameter for the POKE command; i.e., the address.

ASCII Codes

But what values should be poked? The second parameter of a POKE is the value that is to be stored in the address. For this methodology the ASCII equivalent values of the letters and numbers are used. The Apple provides three ways to display the characters: normal, reverse and flashing. All three are accessible using the POKE command.

On pages 138-139 of the Applesoft manual is a list of the ASCII codes for

Segments		Eight 128-byte segments 40 character lines			
1024					
1.	40 Bytes—Line 1	40 Bytes—Line 9	40 Bytes—Line 17	8 Bytes	
2.	40 Bytes—Line 2	40 Bytes—Line 10	40 Bytes—Line 18	8 Bytes	
3.	40 Bytes—Line 3	40 Bytes—Line 11	40 Bytes—Line 19	8 Bytes	
4.	40 Bytes—Line 4	40 Bytes—Line 12	40 Bytes—Line 20	8 Bytes	
5.	40 Bytes—Line 5	40 Bytes—Line 13	40 Bytes—Line 21	8 Bytes	
6.	40 Bytes—Line 6	40 Bytes—Line 14	40 Bytes—Line 22	8 Bytes	
7.	40 Bytes—Line 7	40 Bytes—Line 15	40 Bytes—Line 23	8 Bytes	
8.	40 Bytes—Line 8	40 Bytes—Line 16	40 Bytes—Line 24	8 Bytes	
					2047

Table 1. Map of Apple screen buffer.

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[illegible]

letters, numbers and characters. These are the codes that are produced by the BASIC function ASC (p. 60 of the Applesoft manual). These codes, when poked onto the screen, do not produce the normal version of the characters but the flashing version. Thus, if 1024, 65 is poked, the Apple will print the letter A in the upper left-hand corner, in the flashing mode. (The decimal version of the ASCII code for A is 65.)

To access the other versions of the characters, another set of codes is used. The complete list of codes needed to access all three modes using POKE are listed in Table 3. The codes for each mode are numerically related. Adding 64 to the reverse code gives the flashing code; adding 64 to the flashing code gives the normal character code.

It may be more useful to look at this in terms of the ASC function. For example, POKE 1024, ASC("A") displays a flashing mode A on the screen (the same as POKE 1024,65); POKE 1024,ASC("A")-64 produces a reverse A; and POKE 1024,ASC("A")+128 displays a normal mode A. Using this relationship, the ASC function can selectively translate character strings and print them on the screen in a variety of modes on the same line. Another application of this technique is to subtract or add to a currently displayed character, thereby changing its mode.

This technique of poking characters onto the video screen has many possibilities, and frees the programmer from some of the limitations and

nuisances of the standard print command. One caution: indiscriminate poking can cause the computer to crash, resulting in the loss of the program. So be careful to check that the addresses poked are valid for the

screen before running them. A major drawback of this technique is that only one character can be printed per POKE. This entails some additional programming, but the flexibility is usually worth the effort. ■

	Reverse	Flashing	Normal		Reverse	Flashing	Normal
@	0	64	128	Space	32	96	160
A	1	65	129	!	33	97	161
B	2	66	130	"	34	98	162
C	3	67	131	#	35	99	163
D	4	68	132	\$	36	100	164
E	5	69	133	%	37	101	165
F	6	70	134	&	38	102	166
G	7	71	135	'	39	103	167
H	8	72	136	(	40	104	168
I	9	73	137	)	41	105	169
J	10	74	138	*	42	106	170
K	11	75	139	+	43	107	171
L	12	76	140	,	44	108	172
M	13	77	141	-	45	109	173
N	14	78	142	.	46	110	174
O	15	79	143	/	47	111	175
P	16	80	144	0	48	112	176
Q	17	81	145	1	49	113	177
R	18	82	146	2	50	114	178
S	19	83	147	3	51	115	179
T	20	84	148	4	52	116	180
U	21	85	149	5	53	117	181
V	22	86	150	6	54	118	182
W	23	87	151	7	55	119	183
X	24	88	152	8	56	120	184
Y	25	89	153	9	57	121	185
Z	26	90	154	:	58	122	186
[	27	91	155	;	59	123	187
\	28	92	156	<	60	124	188
]	29	93	157	=	61	125	189
^	30	94	158	>	62	126	190
_	31	95	159	?	63	127	191

Build a "Quick Fox" Terminal Tester

By T. K. Davies

One of the recurring requirements for the person who installs or repairs computer equipment is a black box to plug in and turn on which continuously sends ASCII characters. Whether he is building a new serial I/O board, troubleshooting a video terminal or trying to adjust a teletypewriter, it is hard to adjust or measure in one place and, with the free hand, punch keys on a keyboard.

This black box, which will free his hands, is a "quick brown fox" generator. Historically, these were large mechanical devices which had a character wheel with "the quick... fox..." coded on it, a contact-type reader and a serializer. Such a device is hardly reasonable for today's computer work, so the following "quick-fox" unit was developed (Photo 1).

Before the project was started, I drew up a "wish list" of desirable features:

1. The unit must generate all printable characters.
2. It should be useful for both RS-232 and 20 mA loops.
3. It should have selectable baud rates.
4. The unit should be portable, battery-powered and easy on the batteries.
5. It should be easy to operate and connect to commercial terminals.
6. It should be inexpensive and easy to build from readily available parts.

ROM Character Generators

Designing the Q-Fox to meet these needs required that many alterna-

tives be examined. Referring to the block diagram, Fig. 1, you will see that the first design consideration was the character generator. The most obvious choice for generating all the characters would be a commercial ROM with all the ASCII characters precoded.

An examination of several manufacturers turned up National's MM5220DF quick-brown-fox generator ROM, but it has several drawbacks. It does not generate all the ASCII characters; it is a PMOS chip and requires level shifters for use with CMOS ICs; and it needs several supplies and is consequently a power hog. So this was ruled out.

My next thought was to use a custom PROM and program it to do the job. Since I need only a little over 64 characters, it is hardly a job for the more common PROMs such as a 2708 or 1702. Also, neither of these chips is material for a battery-supplied test set. There are CMOS PROMs, but they are expensive and not readily programmable by most available PROM burners.

Up Counter Character Generator

After looking at the character set that was needed (all ASCII codes from octal 040 to 140 if uppercase only, or to octal 200 if both uppercase and lowercase are required), I saw that the sequential set could be generated by an up counter. Just preload with the first character (space 040) and run up to the last character ("←")



Photo 1. Q-Fox on background of sample printout.

T. K. Davies is a chemistry professor at the University of Victoria, Victoria, B.C., Canada V8W 2Y2.

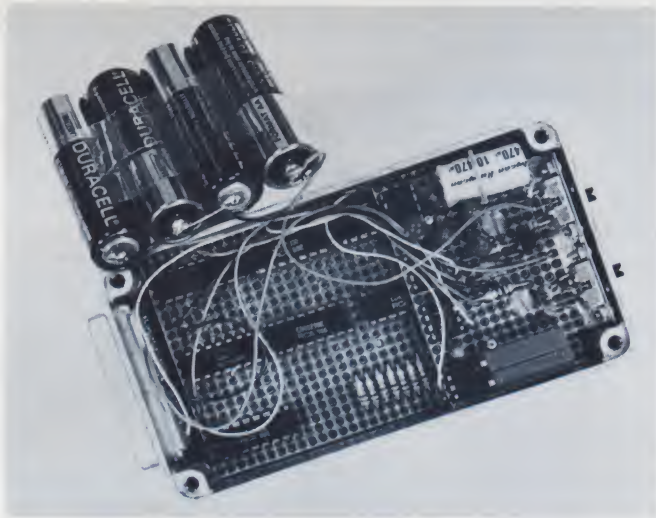


Photo 2. Interior view with batteries removed. But still assembled.

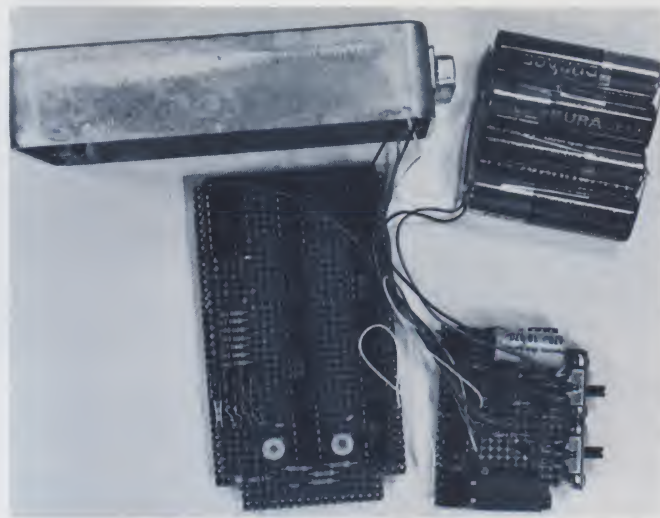


Photo 3. All boards removed from case.

137 or DEL 177), reset and repeat the sequence. This part of the circuit is done by IC4 and IC5, two cascaded 4029s.

If nothing more were required to generate a string of characters on a terminal, the generator would be trivial. But if you run this device on a teleprinter, it will print a line and then pile up all successive lines in the last column. What is needed is some means of generating, at a minimum, a carriage return and line feed at the end of the sequence. If the unit is to be used with line printers, there must also be provision for adding several null or fill characters after the CR and LF, to allow the carriage to completely return and stabilize in column one.

Add Ten Characters

This is where the block labeled ADD TEN CHRS comes into play. The circuit is composed of IC8, IC13 and parts of IC7 and IC12. It operates as follows. The section called 140 DECODE (IC7) senses that the last character has been generated (actually, it is one more than the last character, but it simplifies decoding and helps the parts count).

The decoded pulse is inverted in a second gate of IC7 called POWER ON RESET. In conditions other than just after turn on, this is only an inverter; however, POWER ON RESET and the inverter make sure that the line of characters starts at 040 (a space), and not with some random character. The inverted DECODE 140 pulse sets the RS flip-flop IC8. This, in turn, puts D of the second flip-flop high, and on the next clock pulse Q will go high. With Q high, the

associated AND gate (IC7a and an inverter) will pass clock pulses to the IC13, the ten-character scanner.

IC13 acts like a bucket brigade, in that a high or one is passed sequentially from 0 to 9. During the scan the diode matrix elements are connected one after another. When the high reaches 9, a pulse is sent to the reset line of IC8; this causes Q to go low and D of the next flip-flop to go low, which stops the clock pulses from reaching IC13. Thus, only ten pulses are generated until the DECODE 140 gate signals to send another ten. If, for some reason, a shorter sequence than ten is required, just take off the reset line to IC8 at an earlier point.

Custom Characters

These custom characters are generated by jamming ten characters into the counter, which in this mode is just a buffer into the parallel-to-serial converter. A diode matrix is connected across the load input of the two 4029 counters. The load inputs are pulled down (low or zero load), but during the add-ten-character sequence they can be pulled high (one)

by diodes of the programming array.

The diagram for the array (see Fig. 2) shows an N.C. for the first character; in effect, this is a null. The settling time of the add-ten circuit requires that this be a null. Next are the CR, LF and two fill characters. If you are just using the Q-Fox for video terminals, these are not required. The next four characters are vanity characters, in our case UVIC, and the last character is a space, which is also required since it is the startpoint for the up counters. To custom-program the optional characters, look up the ASCII equivalents and add the appropriate diodes to the matrix. The octal values for each input are identified on the schematic (Fig. 2).

Serializer

The next consideration in building the Q-Fox was the serializer. My first approach was a CMOS UART. Although this worked well and used low power, it was not used in the final version because it was costly, large and had many redundant features for this application. The serializer comprised a 4021 and a 4013.

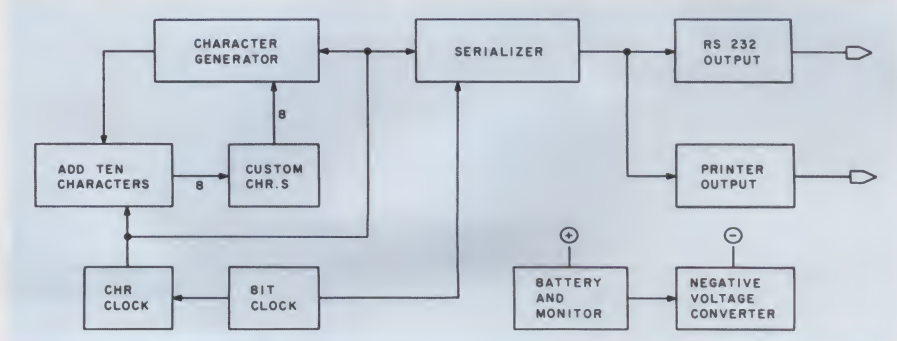


Fig. 1. Block diagram for Q-Fox computer terminal tester.

This parallel-in serial-out configuration gives eight bits of data, and provides a start and two stop bits. For a detailed description of its operation see the *CMOS Cookbook* (Reference 1). The serializer requires two clocks—a bit clock and a character clock.

Clocks

The bit clock is a 555-IC1. I chose the 555 after looking at several baud rate chips. One drawback of the baud rate generators is the 16-times output. This output is for UARTs and requires a divide-by-16 to be useful here. The schematic (Fig. 2) shows two rates and gives values for 110

and 300 baud; these are typical of printers and are available on most video terminals.

If the unit is to be used other than for printers, the bit clock can be run at a higher baud rate by selecting new values for the 555 (see Reference 2). The Q-Fox has been run using an external clock at up to 4800 baud. The character clock is derived from the bit clock. IC2, a 4029, is connected as a divide-by-11 counter to provide the CHR CLK.

Output Drivers

This completes the logic part of the Q-Fox, but we need to provide the

RS-232 and 20 mA drivers. The loop output is the simplest possible, and works well even at elevated baud rates. If the loop is driving a printer which is not despiked, a small capacitor 0.22 μ F or so could be added from the Q1 collector to ground. This will reduce the upper rate for the loop supply but will aid in driving some printers.

The RS-232 output is provided by an operational amplifier IC9. I chose a 1458 for its low power consumption. The output pins for the RS-232 are standard, but, since a loop supply is not an RS-232 signal, two unassigned pins were used. These are common to a number of terminals, e.g., the Lear Siegler ADM-3.

Both of the output drivers require bipolar supplies. RS-232 switching can be accomplished by 3 to 4 V, but the loop supply needs 5–6 V. The prototype was built with two batteries and two 9 V transistor batteries. This worked well, except that the batteries took up as much room as the circuit, and, at 9 V, the CMOS drew nearly twice the current. My next choice was a new chip from Intersil. The ICL 7660 is a negative voltage converter. Since this is a new chip it is worth a few lines of comment.

The ICL 7660

This is a battery (or supply) inverter chip. With the addition of three or four components, supplies from –1.5 to –10 V can be generated. The chip contains all the parts of a voltage doubler. By adding the external capacitors, the unit is complete.

An RC oscillator and several MOS switches (which act like diodes on a conventional doubler) convert and invert the positive supply. The voltage is then regulated. The circuit works with high efficiency, typically 98 percent, in most applications. It can be used for dynamic RAM or processors which require negative supplies, or, as in our case, an operational amplifier and level translator. I found it needed a capacitor across the main supply rail to stop the spikes from the inverter from glitching the main logic.

Battery Monitor

The last circuit required is a battery monitor, which may appear to be a frill but is necessary to ensure that the battery is in good condition. The RS-232 and the loop supply do have lower limits for proper operation. Although the main logic board will run

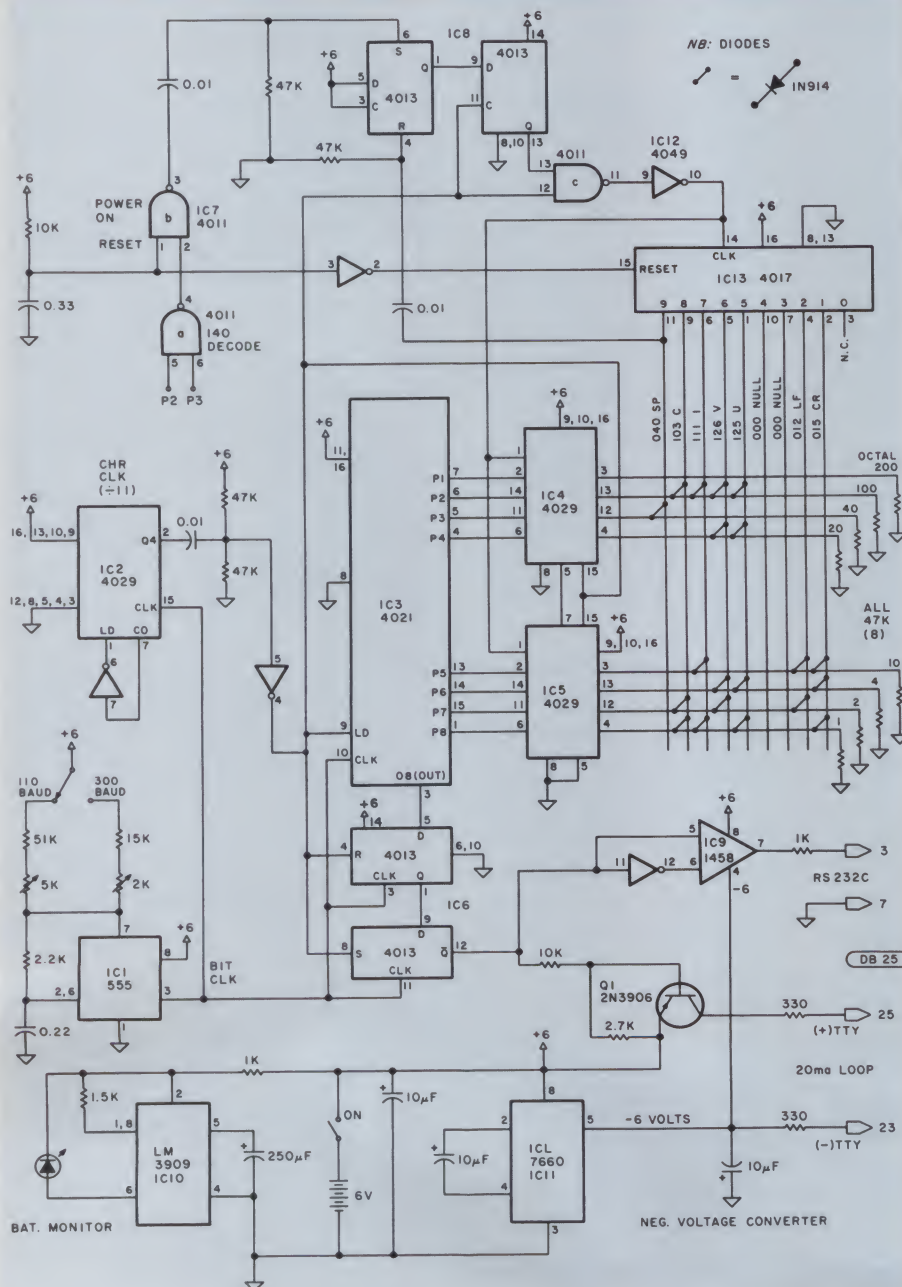


Fig. 2. Schematic diagram for Q-Fox computer terminal tester.

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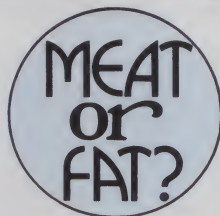
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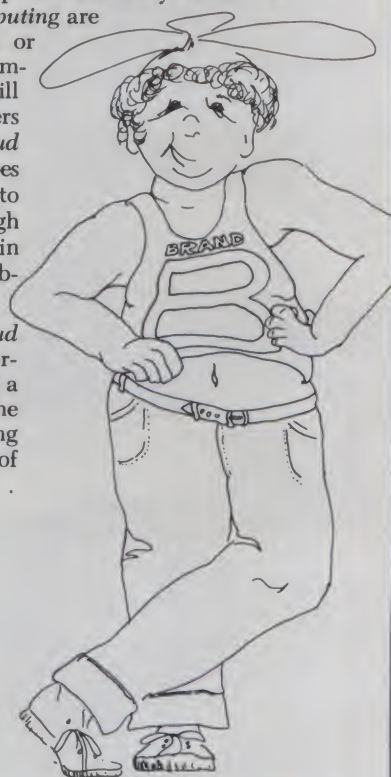
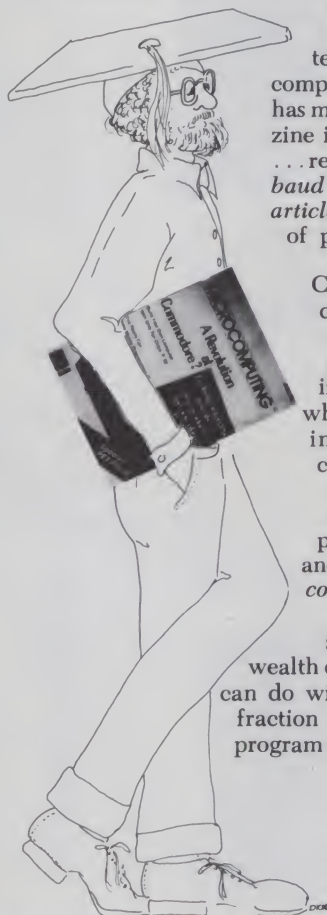
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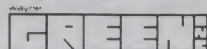
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to well below 3 V, the output drivers would be marginal well before this point. The battery monitor will register if the battery is above 5 V; this means that when the LED is flashing the unit is working properly.

Alkaline batteries were used to ensure maximum running time. Regular AA cells will work just as well, but for a shorter time. The drain is 10 mA for an RS-232 unit under test and 16 mA (average) for a loop supply driven printer. The better batteries should provide months of normal operation.

Construction

The unit was constructed in a small alloy box (2.5×4.5×1.25 inches).

The generator is constructed on two boards. The main logic board is full-sized (see Photo 4) and comprises all but the battery monitor, RS-232 and TTY drivers and the negative voltage convertor, which are on a partial board (see Photo 5). The batteries are solder-connected, wrapped in a thin piece of foam and set in at the end of the small board.

The power switch and the baud rate switch protrude through the case at one end, and the RS-232 (DB25) connector protrudes through the other end; a hole for the LED is on the top of the box. The boards are cut from a Vector 4112-4DP universal board. If you want to duplicate the unit exactly, note that the bottom sec-

tion is three rows wide (running e. d to end) and the small board is two rows (running side to side). The unit seems to be insensitive to parts layout, so any reasonable configuration would probably be all right.

How to Use It

A few comments on the use of the Q-Fox would be worthwhile. Connection to a Teletype, such as the model 33, is straightforward. Pin 25 of the DB25 plug is the positive of the loop supply, and pin 23, the negative. Connection for RS-232 is on pin 3 for signal and pin 7 for ground. Note that some terminals used with modems and line drivers require jumpers to enable the RS-232 line—the easiest way to check is to look at the cable ends of the particular terminal and see if jumpers are present on the cable plug. The unit has been used on Lear Siegler, Heath and Westinghouse terminals and model 33 and 35 Teletypes.

If you are plugging the unit directly into the terminal, a male plug is required; if using it as a computer end of the RS-232 cable, use a female socket, DB25 connector. If using it for a variety of applications, you may need to make some DB25 female-to-female adapters, or male-to-female if the socket is recessed on the terminal. Determine your requirement before you install the DB25 connector. ■

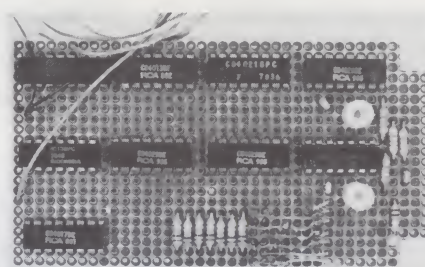


Photo 4. Closeup of the main logic board [note stand offs to support upper small board]. Diode matrix is in the bottom right. RC components are on the end of the board.

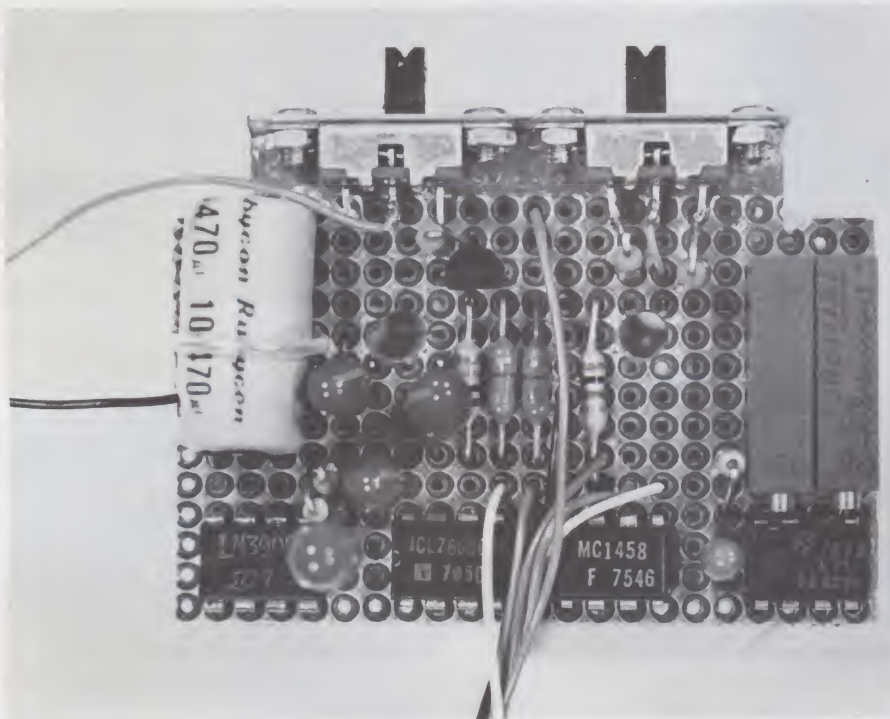


Photo 5. Closeup of output drivers, battery monitor, inverter and bit clock.

References

Lancaster, D., *CMOS Cookbook*, Sams & Co., New York, p. 317.
Lancaster, D., *TTL Cookbook*, Sams & Co., New York, p. 171.

Parts List

- | | |
|--------------------------------|----------|
| IC1 | LM 555 |
| IC2 | 4029 |
| IC3 | 4021 |
| IC4 | 4029 |
| IC5 | 4029 |
| IC6 | 4013 |
| IC7 | 4011 |
| IC8 | 4013 |
| IC9 | MC 1458 |
| IC10 | LM 3909 |
| IC11 | ICL 7660 |
| IC12 | 4049 |
| IC13 | 4017 |
| Q1 | 2N3906 |
| Diodes 1N914 | |
| 1—FLV-117 LED | |
| 3—10 uF/10 V tant. | |
| 1—0.22 uF/10 V tant. | |
| 3—.01 uF Cer. | |
| 1—250 uF/10 V electrolytic | |
| 1—0.33 uF/10 V tant. | |
| 12—47k 1/4W resistors | |
| 2—10k 1/4W resistors | |
| 2—1k 1/4W resistors | |
| 2—330k 1/4W resistors | |
| 1—1.5k 1/4W resistors | |
| 1—2.7k 1/4W resistors | |
| 1—2.2k 1/4W resistors | |
| 1—15k 1/4W resistor | |
| 1—51k 1/4W resistor | |
| 1—5k trimpots | |
| 1—2k trimpots | |
| 1—DB25 (RS-232 connector). | |
| 1—Vector 4112-4DB PC board. | |
| 2—SPDT slide switches. | |
| 1—Hammond 1590B utility box. | |
| 4—Mallory MN1500 1.5 AA cells. | |

Multiplying by 1's and 0's

By Leo J. Scanlon

Multiplication. It's a subject that gave most of us untold misery in elementary school. But now, having memorized all of those cursed multiplication tables, we can confidently multiply anything by anything. Right?

Yes, right, as long as the anythings are *decimal* numbers. Unfortunately, if you want to write an assembly language program to perform a multiplication on your Apple, AIM 65, TRS-80 or other microcomputer, you're back at square one, because (a) the numbers being multiplied are *binary* values and (b) none of the popular eight-bit microprocessors has a multiply instruction.

That's the bad news. The good news is that multiplication techniques are covered in virtually every tutorial and textbook on assembly language programming. Regardless of which book you pick up, you'll learn how it's possible to multiply two binary values, using the add and shift instructions of the microprocessor. The discussions of multiplication vary in quality—depending on the author's inclination and the software or hardware orientation of the book—but typically these books give only a summary of the fundamental principles and an example or two (usually, just an eight-bit by eight-bit unsigned multiply). From there on, readers are left to their own devices.

A cop-out? Maybe. But most authors (and, apparently, their publishers) feel that their book must cover so many topics that they can't afford to

devote much page space to a "simple" task like multiplication.

Admittedly, a brief once-over will suit the needs of the casual reader/programmer, but what about those who want to multiply numbers that are longer than eight bits, or those who want to multiply *signed* (two's complement) numbers?

This article is intended to serve both kinds of readers: beginners who want an overview of multiplication and serious programmers who need a more detailed treatment than the popular literature provides. The programs are written in 6502 assembly language, but the accompanying text and flowcharts should make them readily convertible for use with any of the other eight-bit microprocessors.

Back to Fourth Grade

Before we discuss multiplying binary numbers, it may be instructive to review the mechanics of multiplying decimal numbers, the way we used to do it in elementary school with pencil and paper. As you will recall (in these days of calculators, it may be a bit hazy), with pencil and paper you write the multiplicand on one line and the multiplier on the line below it, and then grind out a series of multiplications—one for each digit in the multiplier. Each partial product is recorded directly below its multiplier digit, causing it to be offset one digit position to the left of the preceding partial product. When all of the partial products have been cal-

culated, they are added to produce the final product.

For example, multiplying the number 124 by the number 103 looks like this:

124	Multiplicand
$\times 103$	Multiplier
372	Partial Product #1
000	Partial Product #2
124	Partial Product #3
12772	Final Product

(Of course, you don't normally write down the all-zeroes partial product, but rather just skip to the next digit position.)

It's important to remember why we write the partial products offset from each other: it's because each partial product is associated with a multiplier digit of a different decimal weight. Remember that the preceding problem can also be written in the form

$$103 \times 124 = (3 \times 124) + (0 \times 124) + (100 \times 124)$$

Or, we could use an equivalent form

$$103 \times 124 = (3 \times 1 \times 124) + (0 \times 10 \times 124) + (1 \times 100 \times 124)$$

to illustrate that the digits 3, 0 and 1 in the multiplier have decimal weights of 1, 10 and 100, respectively.

In the preceding problem, both the multiplier and the multiplicand happen to be nonnegative (positive or unsigned) numbers. How would the pencil-and-paper operation have changed if one or both was a negative

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This subroutine multiplies an 8-bit unsigned multiplicand (MPND) by an 8-bit unsigned multiplier (MPLR), and returns the 16-bit product in locations PROD (low byte) and PROD+1 (high byte).

```

0000          MPLR=$20
0000          MPND=$21
0000          PROD=$22
0000          *=$400
0400 A9 00 MLT8U LDA #0          Clear product MSBY
0402 A2 08 LDX #8          Multiplier bit count = 8
0404 46 20 NXTBT LSR MPLR      Get next multiplier bit
0406 90 03 BCC ALIGN      Multiplier bit = 1?
0408 18 CLC          Yes, add multiplicand
0409 65 21 ADC MPND      to partial product
040B 6A 21 ALIGN ROR A          Rotate product right
040C 66 22 ROR PROD
040E CA DEX
040F D0 F3 BNE NXTBT      Loop until 8 bits are done
0411 85 23 STA PROD+1      Store product MSBY
0413 60 RTS

```

Example 1. An eight-bit by eight-bit unsigned multiplication subroutine.

number? Very little, because we all know that if one number is positive and the other is negative, the product will be negative—so you tack a minus sign onto the answer. Similarly, if both multiplier and multiplicand are negative, the product will be positive—so you omit the minus sign from the answer (or put a plus sign on it, if you're a purist). With binary numbers, though, there's quite a bit of difference between multiplying unsigned numbers and multiplying signed numbers, because signed numbers are represented in two's complement form. We'll be looking at both unsigned and signed multiplication later, but for now, let's briefly discuss how binary numbers can be multiplied.

Binary Multiplication vs. Decimal Multiplication

Binary multiplication is much simpler than decimal multiplication, because binary multipliers consist of only the digits 0 and 1, whereas decimal multipliers can be made up of the digits 0 through 9. In binary multiplication, the partial product will always be simply a copy of the multiplicand if the multiplier digit is 1, and it will be 0 if the multiplier digit is 0.

The binary equivalent of our previous 103 × 124 example looks like this:

```

  01111100 Multiplicand (=124)
× 01100111 Multiplier (=103)
-----
  01111100
 01111100
 01111100
 00000000
 00000000
 01111100
 01111100
 00000000
-----
011000111100100 Final Product (=12772)

```

This example gives a good indica-

tion of the way in which eight-bit microprocessors must perform multiplication operations. There are some important differences, however. When performing a binary multiplication by hand, you must calculate the final product by adding the partial products, column-by-column. (And if you think that's easy, try it! The carries can drive you bonkers.) The operation is similar on a computer, but instead of waiting until all of the individual partial products are calculated before deriving the final product, *computer programs update the partial product after each multiplier bit is examined*. By doing this, the final product is generated when the last bit of the multiplier has been processed.

Moreover, when multiplying by hand, each partial product is offset one digit position to the left of the preceding partial product, to account for the weight of the multiplier bit. In a computer, it is easier to shift the partial product each time it is updated, thereby aligning it to receive the contribution of the next multiplier bit. The partial product may be shifted either right or left, depending on whether your program is examining the multiplier bits from right to left (low-order to high-order) or from left to right (high-order to low-order). In this article, the multiplier will be processed right-to-left, the way you would do it by hand, so the partial product will be shifted to the right.

In summary, the following applies when multiplying binary numbers by a computer:

If the multiplier bit is a 1, add the multiplicand to the partial product, and then shift the sum one bit position to the right. If the multiplier bit is a 0, shift the current partial product one bit position

to the right, with no addition.

In writing a multiplication program for your microcomputer, which instruction would you expect to use to perform the add and right-shift operations? With a 6502-based microcomputer, such as Apple II, KIM-1, SYM-1 or AIM 65, the addition will be performed with the 6502's only add instruction, add to accumulator with carry (ADC). The shifting will be performed with the shift right (LSR) or rotate right (ROR) instruction.

With this background, let's examine the software that will be needed to multiply unsigned or signed numbers.

Multiplying Unsigned Numbers

As you probably know, in an unsigned number, each data bit carries a certain binary weight, according to its position within the number. Data bits are numbered from right to left, with the rightmost bit labeled as bit 0 and the leftmost bit labeled bit 7. The bit numbering scheme has a direct correlation to the binary weights, in that bit 0 has a weight of 2^0 (decimal 1) and bit 7 has a weight of 2^7 (decimal 128). Therefore, a single byte can represent an unsigned number from decimal 0 (binary 00000000) to decimal 255 (binary 11111111).

Single-Precision Unsigned Multiplication

Certainly, the easiest place to begin is by developing a program—a subroutine, actually—to multiply two eight-bit unsigned numbers in memory. If the multiplicand and the multiplier are both eight bits long, how long will the product be? Well, we know that the worst case involves multiplying 255 by 255, which gives a product of 65,025. To hold a value of 65,025, we need 16 bits, or two bytes.

At this point, we can draw the flowchart that will serve as the blueprint for an eight-bit (or single-precision) multiplication subroutine. This flowchart must do five things:

1. Initialize a two-byte product in memory to zero, and a multiplier bit counter to eight.
2. Shift the multiplier right one bit position into carry.
3. Interrogate the state of the multiplier bit that's in carry. If carry = 1, add the multiplicand to the partial product.
4. Rotate the partial product right, into the final product location's least-

This subroutine multiplies a 16-bit unsigned multiplicand (MPND, MPND+1) by a 16-bit unsigned multiplier (MPLR, MPLR+1), and returns the 32-bit product in locations PROD (low byte), PROD+1, PROD+2 and PROD+3 (high byte).

```

0000          MPLR=$20
0000          MPND=$22
0000          PROD=$24
0000          *=$400
0400 A9 00  MLT16  LDA  #0      Clear P2 and P3 of product
0402 85 26          STA  PROD+2
0404 85 27          STA  PROD+3
0406 A2 10          LDX  #16     Multiplier bit count = 16
0408 46 21  NXTBT  LSR  MPLR+1   Get next multiplier bit
040A 66 20          ROR  MPLR    into Carry
040C 90 0B          BCC  ALIGN   Multiplier bit = 1?
040E A5 26          LDA  PROD+2   Yes, fetch P2
0410 18              CLC         and add M0 to it
0411 65 22          ADC  MPND
0413 85 26          STA  PROD+2   Store new P2
0415 A5 27          LDA  PROD+3   Fetch P3
0417 65 23          ADC  MPND+1   and add M1 to it
0419 6A 23  ALIGN  ROR  A        Rotate product right
041A 85 27          STA  PROD+3
041C 66 26          ROR  PROD+2
041E 66 25          ROR  PROD+1
0420 66 24          ROR  PROD
0422 CA            DEX           Decrement bit count
0423 D0 E3          BNE  NXTBT    Loop until 16 bits are done
0425 60            RTS

```

Example 2. A 16-bit by 16-bit unsigned multiplication subroutine.

significant byte (LSBY).

5. Decrement the multiplier count. If it is zero, store the final product's most-significant byte (MSBY) in memory, and return; otherwise, go back to process the next multiplier bit.

The flowchart in Fig. 1 performs these five tasks.

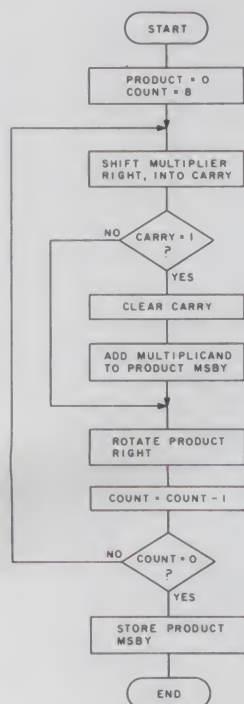


Fig. 1. An eight-bit by eight-bit unsigned multiplication algorithm.

Example 1 is a subroutine (MLT8U) that uses the flowcharted algorithm to multiply the contents of a multiplicand in memory (MPND, assigned to location \$21 here) by the contents of a multiplier in memory (MPLR, assigned to location \$20 here). The 16-bit product is returned in two consecutive locations, PROD and PROD+1. The X register is used to hold the multiplier bit count.

In the MLT8U subroutine, the LSR MPLR instruction at NXTBT causes the multiplier (in memory location \$20) to be shifted, one bit at a time, into carry. If the shifted multiplier bit is a one, the CLC and ADC MPND instructions add the multiplicand to the most-significant byte of the product, and the two rotate instructions at ALIGN (ROR A and ROR PROD) shift the partial product to the right, into the least-significant byte. If the shifted bit of the multiplier is a zero, BCC ALIGN bypasses the add-multiplier operation by branching to the rotate-right sequence at ALIGN. The NXTBT loop is executed eight times, once for each bit in the multiplier.

Double-Precision Unsigned Multiplication

We've just concluded a discussion of eight-bit by eight-bit unsigned multiplication, which lets us multiply two numbers as large as 255. Unfortunately, like a three-legged race team in the Boston Marathon, single-precision multiplication is nice, but

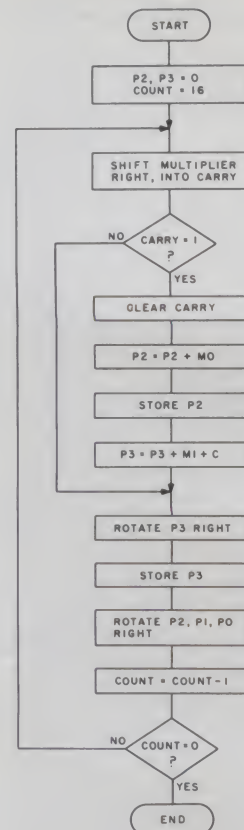


Fig. 2. A 16-bit by 16-bit unsigned multiplication algorithm.

not very practical, since many applications require numbers larger than 255 to be multiplied. Obviously, the next step is to develop a program that will multiply 16-bit, or double-precision, numbers.

Multiplying 16-bit numbers is somewhat more complex than multiplying eight-bit numbers, due to the additional memory involved, but the add-and-shift procedure still applies. With a double-precision multiplication, the multiplier and multiplicand are both 16-bit values, so the product will occupy 32 bits (or four bytes) in memory.

Fig. 2 is a flowchart for a double-precision unsigned multiplication subroutine. The two-byte multiplicand is represented by the symbols M0 (low order byte) and M1 (high-order byte). The four-byte product is represented by the symbols P0 (low-order byte), P1, P2 and P3 (high-order byte). The double-precision algorithm shown in Fig. 2 operates similarly to the single-precision algorithm that has just been discussed. That is, the multiplicand is added to the high-order half of the partial product (P2 and P3, here) if carry is a 1. The result is then rotated one bit to the right,

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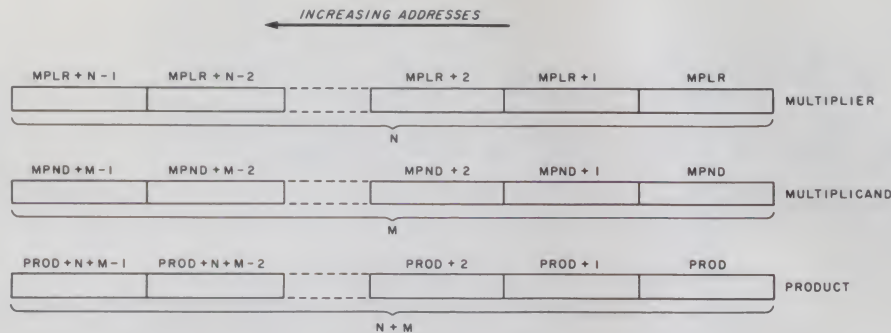


Fig. 3. Multiplier, multiplicand and product in memory.

along with the low half of the partial product.

Example 2 is a subroutine (MLT16) that uses the flowcharted algorithm (Fig. 2) to perform a double-precision unsigned multiplication. In this particular subroutine, the multiplier (MPLR) is in locations \$20 and \$21, the multiplicand (MPND) is in locations \$22 and \$23 and the 32-bit product is returned in locations \$24 (low byte) through \$27 (high byte). Each time a multiplier bit is a one, the MLT16 subroutine must perform two adds, to add the multiplicand to the partial product, and two stores, to update the product in memory. It must also perform four rotate operations (one for each byte in the product). Note that the updated byte P3 is returned to memory *after* the first of the four rotates.

Whither Goest the Multiplier?

If you've run either Example 1 or Example 2 on a microcomputer, you've observed that the multiplier has been cleared to zero in the course of the operation. In many applications, it makes no difference whether or not the multiplier is affected. In other applications, the multiplier must be preserved for one reason or another.

How can the multiplier be preserved? Typically, the first impulse is to preserve it by simply changing the LSR instruction at ALIGN to an ROR instruction. Well, that's a good beginning, but you must be careful to observe that for a rotate to work correctly, the sense of the carry bit must be unchanged from one rotate operation to another. Unfortunately, the add operation between labels NXTBT and ALIGN will *always* alter the carry bit!

With these two considerations in mind, we're on our way to a solution. So far, we've discovered that if you

want to preserve the multiplier you must

1. Rotate, rather than shift, the multiplier, and
 2. Save the state of the carry bit between rotate operations.
- Will these two modifications alone preserve the multiplier? Well, almost. They don't quite do the job because the final rotate operation will leave the most-significant multiplier bit in carry, and all other less-significant multiplier bits displaced one bit position to the left. So, in addition, you must

3. Rotate the multiplier one more time, at the end of the operation.

By applying these three rules to Example 2, you may come up with a subroutine that looks like the one in Example 3, a double-precision unsigned multiplication subroutine in

which the multiplier is preserved. Since the multiplier must be rotated at two different points in the program (per rules 1 and 3), the rotate instructions are given in a subroutine, called RMPLR. Rule 2 is easily satisfied by executing a push processor status (PHP) instruction after the call to RMPLR, and a complementary pull processor status (PLP) instruction just after the partial product is rotated.

Multiprecision Unsigned Multiplication

Many real-world applications involve multiplying numbers that are longer than two bytes, or have a multiplier and multiplicand of different lengths. For these reasons, it is worthwhile to wind up this discussion of unsigned multiplication by developing a subroutine that can multiply unsigned numbers of *any* length. That is, we will develop a subroutine that multiplies an M-byte multiplicand by an N-byte multiplier, and yields an (N+M)-byte product. Fig. 3 shows how these terms are stored in memory.

The overall approach is unchanged for this general case, but since the multiplier and multiplicand are variable-length values, we will have to compute parameters that were *known* in the eight-bit and 16-bit multiplications. Here, for example, the number

This subroutine is a modified version of the subroutine in Example 2. It has some additional instructions to return the multiplier in its original form.

```

0000                                MPLR=$20
0000                                MPND=$22
0000                                PROD=$24
0000                                *=$400
0400 A9 00      MLT16 LDA #0          Clear P2 and P3 of product
0402 85 26      STA PROD+2
0404 85 27      STA PROD+3
0406 A2 10      LDX #16             Multiplier bit count = 16
0408 18         CLC
0409 20 27 04   NXTBT JSR RMPLR      Go get next multiplier bit
040C 08         PHP                  and save it (carry)
040D 90 0B      BCC ALIGN            Multiplier bit = 1?
040F A5 26      LDA PROD+2           Yes, fetch P2
0411 18         CLC                  and add M0 to it
0412 65 22      ADC MPND
0414 85 26      STA PROD+2           Store new P2
0416 A5 27      LDA PROD+3           Fetch P3
0418 65 23      ADC MPND+1           and add M1 to it
041A 6A         ALIGN ROR A          Rotate product right
041B 85 27      STA PROD+3
041D 66 26      ROR PROD+2
041F 66 25      ROR PROD+1
0421 66 24      ROR PROD
0423 28         PLP                  Retrieve Carry from stack
0424 CA         DEX                  Decrement bit count
0425 D0 E2      BNE NXTBT            Loop until 16 bits are done
0427 66 21      RMPLR ROR MPLR+1     Rotate multiplier right
0429 66 20      ROR MPLR
042B 60         RTS

```

Example 3. A double-precision unsigned multiplication subroutine that preserves the multiplier.

of bits in the multiplier must be determined by multiplying N by eight (with three left-shifts). The length of the product must also be computed, by adding N and M. And whenever the multiplicand needs to be added to the partial product, it will have to be added to the most-significant "M" bytes—still another required computation. These various computations are reflected in Fig. 4, the flowchart for multiprecision unsigned multiplication.

As you can see, the flowchart in Fig. 4 contains the same number of steps as the flowchart for the double-precision case (Fig. 2). That's not surprising, since the same types of operations are being performed, but how do the actual multiplication subroutines compare? That is, what programming overhead is involved in having a general-purpose subroutine rather than a length-specific subroutine? The answer is apparent by comparing Example 4, the multiprecision

unsigned multiplication subroutine, with Example 3, the 16-bit multiplication subroutine. The multiprecision subroutine is *twice as long* as the double-precision subroutine!

Although Example 4 looks complicated, it isn't. Its initialization includes two additional input parameters (the multiplier length, N, and the multiplicand length, M) and two symbolic locations (to hold the product index, PINDX, and the multiplier bit count, MBIT). The subroutine itself differs very little from Example 3, except for the various computations and the use of indexes for addressing.

What lengths of numbers can be multiplied by the subroutine shown in Example 4? Well, you can see that the first seven instructions add N and M, and put the result in an eight-bit register (Y) and an eight-bit memory location (PINDX); therefore, the sum of N and M must not exceed decimal 255. The multiplier bit count ($8 \times N$) is also stored in an eight-bit memory location, so the value of N must not exceed 31. These two limitations allow us to conclude that the multiplicand length, M, must not exceed $(255 - 31)$

This subroutine multiplies **two** variable-length, unsigned integers. The multiplier is stored starting at location MPLR, and is N bytes long. The multiplicand is stored starting at location MPND, and is M bytes long. The product will be "N + M" bytes long, and will be returned in memory starting at location PROD. This subroutine affects the A, X and Y registers.

```

0000      N=$20      Multiplier length
0000      M=$21      Multiplicand length
0000      MPLR=$30    Multiplier loc.
0000      MPND=$40    Multiplicand loc.
0000      PROD=$50    Product loc.
0000      PINDX **+=1 Product index
0001      MBIT **+=1  Multiplier bit count
0002      **=$600

0600 18      MMPYU   CLC      Calculate product index
0601 A5 20      LDA   N      (N+M-1)
0603 AA      TAX
0604 65 21      ADC   M
0606 A8      TAY      and save it in Y
0607 88      DEY
0608 84 00      STY   PINDX  and in PINDX
060A A9 00      LDA   #0     Clear the high M bytes
060C 99 50 00   CLRP  STA   PROD,Y of the product
060F 88      DEY
0610 C4 20      CPY   N
0612 B0 F8      BCS   CLRP
0614 8A      TXA      Calculate multiplier bit count
0615 0A      ASL   A
0616 0A      ASL   A
0617 0A      ASL   A
0618 85 01      STA   MBIT  and save it in MBIT
061A 20 4A 06   NXTBT  JSR   RMPLR Get next multiplier bit
061D 08      PHP      Save resulting Carry
061E 90 E1      BCC   ALIGN Multiplier bit = 1?
0620 A4 20      LDY   N      Yes. Add multiplicand to
0622 A2 00      LDX   #0     high M bytes of product
0624 18      CLC
0625 B9 50 00   AMPND  LDA   PROD,Y
0628 75 40      ADC   MPND,X
062A 99 50 00   STA   PROD,Y
062D C8      INY
062E E8      INX
062F 08      PHP      Save Carry between adds
0630 C4 00      CPY   PINDX
0632 F0 04      BEQ   PULLC
0634 90 02      BCC   PULLC
0636 B0 04      BCS   GOROT
0638 28      PULLC  PLP
0639 4C 25 06   JMP   AMPND
063C 28      GOROT  PLP
063D 18      CLC
063E A6 00      ALIGN  LDX   PINDX
0640 76 50      RPROD  ROR   PROD,X
0642 CA      DEX
0643 10 FB      BPL   RPROD
0645 28      PLP      Retrieve Carry from stack
0646 C6 01      DEC   MBIT  Multiplier fully processed?
0648 D0 D0      BNE   NXTBT No. Loop for next bit
064A A6 20      RMPLR  LDX   N      Yes. Rotate multiplier right
064C CA      DEX
064D 76 30      RBYTE  ROR   MPLR,X
064F CA      DEX
0650 10 FB      BPL   RBYTE
0652 60      RTS

```

Example 4. A multiprecision unsigned multiplication subroutine.

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=224. In summary, then, the subroutine in Example 4 can multiply a multiplicand up to 244 bytes long by a multiplier up to 31 bytes long, to yield a product that can be up to 255 bytes long.

Multiplying Signed Numbers

Subroutines that have been developed in the preceding parts of this article can be used to multiply signed numbers as well as unsigned numbers, provided that the signed multiplier and multiplicand are both positive. In other words, the preceding subroutines can be used to multiply non-negative integer numbers. However, many applications require a negative multiplicand to be multiplied by a positive multiplier (or vice versa), or a negative multiplier to be multiplied by a negative multiplier.

The signs of the multiplier and multiplicand present no problem if you are multiplying decimal numbers with pencil and paper, because you can simply attach a minus sign to the answer if either of the operands was negative! Unfortunately, things don't go that easily if you are multiplying two's complement binary numbers.

Pencil-and-Paper Two's Complement Multiplication

To see the problems you get into

This article deals with multiplication operations on signed and unsigned binary numbers. In an unsigned number, each data bit carries a certain binary weight, according to its position within the number. Within each byte, data bits are numbered from right to left, with the rightmost bit labeled as bit 0 and the leftmost bit labeled as bit 7.

This bit numbering scheme has a direct correlation to the binary weights in that bit 0 has a weight of 2^0 (decimal 1), bit 1 has a weight of 2^1 (decimal 2), and so on. Thus, bit 7 has a weight of 2^7 (decimal 128). The assignments can be summarized as follows:

7	6	5	4	3	2	1	0	Bit position
2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰	Binary weight
128	64	32	16	8	4	2	1	Equivalent decimal weight

As you can see, a single byte can represent an unsigned number from 0 (binary 00000000) to decimal 255 (binary 11111111).

In a signed number, the seven low-order bits (bits 0 through 6) represent data, and have the same relative weights as the bits in unsigned numbers. The most-significant bit (bit 7) represents the sign of the number. If the number is positive or zero, bit 7 is a logic 0. If the number is negative, bit 7 is a logic 1. A single byte can represent a positive signed number from 0 (binary 00000000) to +127 (binary 01111111), or a negative signed num-

ber from -1 (binary 11111111) to -128 (binary 10000000).

Why is -1 represented by binary 11111111, rather than by 10000001? The answer is that negative signed numbers are represented in two's complement form. The two's complement form was introduced to eliminate the problems that are associated with allowing zero to be represented in two separate forms, binary combination 00000000 (the positive form) and binary combination 10000000 (the negative form). Using two's complement, zero is represented by only one form, the binary combination 00000000.

To derive the negative two's complement form of a binary number, you simply take the positive form of the number, reverse the sense of each bit (change each 1 to a 0, and each 0 to a 1) and add 1 to the result. The following example shows the steps required in deriving the binary representation of -32 in two's complement form:

+00100000	+32
11011111	One's complement
+ 1	Add 1
11100000	-32 in two's complement form

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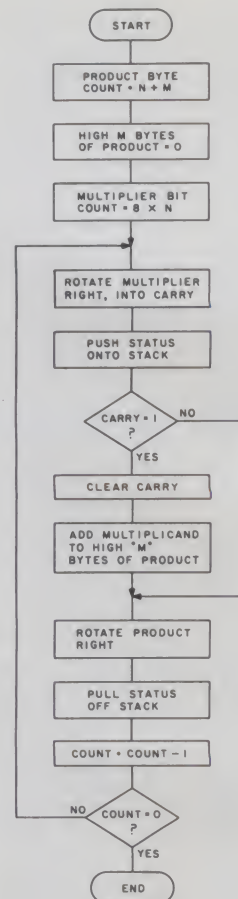
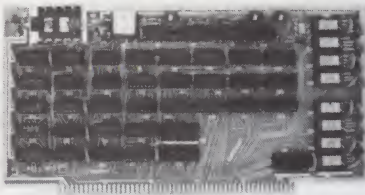


Fig. 4. A multiprecision unsigned multiplication algorithm.

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multiplying with two's complement negative numbers, let's work out our 103 times 124 example once more, but with a negative multiplier (-103). The pencil-and-paper version will look like this:

```

    01111100 Multiplicand (= +124)
  x 10011001 Multiplier (= -103)
  -----
    01111100
   00000000
  00000000
 01111100
101111100
00000000
00000000
01111100
-----
10100101000011100 Product (= +18972)

```

Not only is this answer too large (recall that the correct magnitude is 12772), but it has the wrong sign as well! Incidentally, the situation does not improve if you multiply -124 by -103. That multiplication will give you a product of +20196.

What, then, can be done to obtain a

correct product when we want to multiply negative numbers? Certainly, one valid solution would be to take the two's complement of the negative operand(s), then multiply these two now-positive numbers. If just one of the operands was negative, the resulting product must be two's complemented. If both of the operands were negative, the (positive) product is correct as it stands.

Booth's Algorithm for Signed Multiplication

A much faster solution, and one that does not require either operand to be altered nor the product to be adjusted, is to use a method called Booth's Algorithm. This algorithm is implemented in many of the multiplier chips on the market, and is fully described in Advanced Micro Devices' *Digital Signal Processing Handbook* (John R. Mick, "Understanding

Booth's Algorithm in 2's Complement Digital Multiplication," pp. 5-23 through 5-27).

Booth's Algorithm takes advantage of the fact that a string of zeroes in the multiplier requires no additions, but just shifting the partial product, and that a string of ones running from binary weight 2^r to weight 2^s represents a multiplier of $2^{s+1} - 2^r$. For example, if the multiplier = 00001110, then $r=1$ and $s=3$ and $2^4 - 2^1 = 14$. Note that whereas our previously-described "add-and-shift" algorithm requires three additions for this example, Booth's Algorithm requires only two operations: an addition at weight 2^{s+1} and a subtraction at weight 2^r .

So, when a multiplier is being processed in right-to-left (least-significant bit to most-significant bit) order, Booth's Algorithm boils down to this:

Subtract the multiplicand from the partial product when you find the

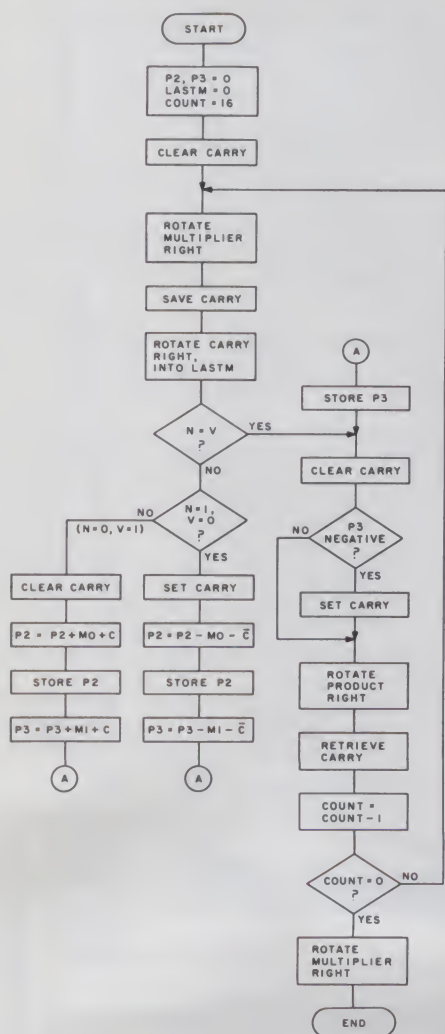


Fig. 5. A double-precision signed multiplication algorithm.

This subroutine multiplies a 16-bit signed multiplicand (MPDN, MPND+1) by a 16-bit signed multiplier (MPLR, MPLR+1), and returns the 32-bit product in locations PROD (low byte), PROD+1, PROD+2 and PROD+3 (high byte).

0000		MPLR=\$20	Multiplier
0000		MPND=\$22	Multiplicand
0000		PROD=\$24	Product
0000		LASTM *+=1	Previous multiplier bit
0000		*=\$400	
0400 A9 00	MLT16S	LDA #0	Clear P2 and P3 of product
0402 85 26		STA PROD+2	
0404 85 27		STA PROD+3	
0406 85 00		STA LASTM	Clear LASTM
0408 A2 10		LDX #16	Multiplier bit count = 16
0408 18		CLC	
040B 20 46 04	NXTBT	JSR RMPLR	Go get next multiplier bit
040E 08		PHP	and save it (as Carry)
040F 66 00		ROR LASTM	and put it in LASTM
0411 24 00		BIT LASTM	This bit (N) = last bit (V)?
0413 10 10		BPL CHKPOS	
0415 70 1D		BVS ALIGN	
0417 38		SEC	No. N = 1 and V = 0, so
0418 A5 26		LDA PROD+2	subtract multiplicand
041A E5 22		SBC MPND	
041C 85 26		STA PROD+2	
041E A5 27		LDA PROD+3	
0420 E5 23		SBC MPND+1	
0422 4C 32 04		JMP SP3	
0425 50 0D		BVC ALIGN	
0427 18	CHKPOS	CLC	No. N = 0 and V = 1, so
0428 A5 26		LDA PROD+2	add multiplicand
042A 65 22		ADC MPND	
042C 85 26		STA PROD+2	
042E A5 27		LDA PROD+3	
0430 65 23		ADC MPND+1	
0432 85 27	SP3	STA PROD+3	Store product MSBY (P3)
0434 18	ALIGN	CLC	
0435 24 27		BIT PROD+3	P3 negative?
0437 10 01		BPL RPROD	No. Continue with Carry = 0
0439 38		SEC	Yes. Set Carry = 1
043A 66 27	RPROD	ROR PROD+3	Rotate product right
043C 66 26		ROR PROD+2	
043E 66 25		ROR PROD+1	
0440 66 24		ROR PROD	
0442 28		PLP	Retrieve Carry from Stack
0443 CA		DEX	Decrement bit count
0444 D0 C5		BNE NXTBT	Loop until 16 bits are done
0446 66 21	RMPLR	ROR MPLR+1	Rotate multiplier right
0448 66 20		ROR MPLR	
044A 60		RTS	

Example 5. A double-precision signed multiplication subroutine.

first 1 in a string of 1's, add the multiplicand to the partial product when you find the first 0 in a string of 0's, and do nothing when the bit is identical to the previous multiplier bit.

Mathematically, the basic algorithm as developed by Booth is as follows: y_i is the i -th most significant bit of an n -bit multiplier. y_0 is the least-significant bit and y_{n-1} is the most-significant (sign) bit. So that we can perform a comparison on y_0 , we will also define an imaginary less-than-least-significant bit, y_{-1} , and give it a value of 0. X is the multiplicand. Starting with $i=0$, bit pairs y_i and y_{i-1} are compared:

- 1) If $y_i = y_{i-1}$, do nothing.
- 2) If $y_i = 1$ and $y_{i-1} = 0$, subtract X (the multiplicand) from the partial product.
- 3) If $y_i = 0$ and $y_{i-1} = 1$, add X to the partial product.

As with our unsigned "add-and-

shift" multiplications, once the partial product has received the contribution of a particular multiplier bit, it must be right-shifted one bit position. Here, since two's complement numbers are being multiplied, the partial product's sign must be preserved during the shift. In other words, the most-significant bit of the partial product must have the same sense after the shift as it did before the shift.

Signed Multiplication Subroutines

With this groundwork, let's see how Booth's Algorithm can be applied to a couple of "real" signed multiplication subroutines.

Fig. 5 is a flowchart for a double-precision (16-bit by 16-bit) signed multiplication subroutine, based on Booth's Algorithm. The initialization box of this flowchart includes a new parameter, LASTM, which is a memory location that will hold the value

Example 6. A multiprecision signed multiplication subroutine.

This subroutine multiplies two variable-length, signed integers: an N-byte multiplier, starting at location MPLR, and an M-byte multiplicand, starting at location MPND. The product will be returned in memory starting at location PROD. The A, X and Y registers are affected by the subroutine.

0000		N=\$20	Multiplier length
0000		M=\$21	Multiplicand length
0000		MPLR=\$30	Multiplier location
0000		MPND=\$40	Multiplicand location
0000		PROD=\$50	Product location
0000		LASTM **+1	Previous multiplier bit
0000		PINDEX **+1	Product index
0000		MBIT **+1	Multiplier bit count
0000		**=\$600	
0600 18	MMPYS	CLC	Calculate product index
0601 A5 20		LDA N	(N+M-1)
0603 AA		TAX	
0604 65 21		ADC M	
0606 A8		TAY	and save it in Y
0607 88		DEY	
0608 84 01		STY PINDEX	and in PINDEX
060A A9 00		LDA #0	
060C 85 00		STA LASTM	Clear LASTM and
060E 99 50 00	CLRP	STA PROD,Y	high M bytes of product
0611 88		DEY	
0612 C4 20		CPY N	
0614 B0 F8		BCS CLRP	
0616 8A		TXA	Calculate multiplier bit count
0617 0A		ASL A	
0618 0A		ASL A	
0619 0A		ASL A	
061A 85 02		STA MBIT	and save it in MBIT
061C 18		CLC	
061D 20 79 06	NXTBT	JSR RMPLR	Get next multiplier bit
0620 08		PHP	and save it (as Carry)
0621 66 00		ROR LASTM	and in high bit of LASTM
0623 24 00		BIT LASTM	This bit (N) = last bit (V)?
0625 10 20		BPL CHKPOS	
0627 70 3E		BVS ALIGN	
0629 A4 20		LDY N	No. N = 1 and V = 0, so
062B A2 00		LDX #0	subtract multiplicand from
062D 38		SEC	high M bytes of product
062E B9 50 00	SMPND	LDA PROD,Y	
0631 F5 40		SBC MPND,X	
0633 99 50 00		STA PROD,Y	
0636 C8		INY	
0637 E8		INX	
0638 08		PHP	
0639 C4 01		CPY PINDEX	
063B F0 06		BEQ PULLC	

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Example 6 continued.

063D 90 04	BCC	PULLC	
063F 28	PLP		
0640 4C 67 06	JMP	ALIGN	
0643 28	PLP		
0644 4C 2E 06	JMP	SMPND	
0647 50 1E	CHKPOS	BVC	ALIGN
0649 A4 20	LDY	N	
064B A2 00	LDX	#0	No. N = 0 and V = 1, so add multiplicand to high M bytes of product
064D 18	CLC		
064E B9 50 00	AMPND	LDA	PROD,Y
0651 75 40		ADC	MPND,X
0653 99 50 00		STA	PROD,Y
0656 C8		INY	
0657 E8		INX	
0658 08		PHP	
0659 C4 01		CPY	PINDX
065B F0 06		BEQ	PULLC1
065D 90 04		BCC	PULLC1
065F 28		PLP	
0660 4C 67 06		JMP	ALIGN
0663 28	PULLC1	PLP	
0664 4C 4E 06		JMP	AMPND
0667 18	ALIGN	CLC	
0668 A6 01		LDX	PINDX
066A B5 50		LDA	PROD,X
066C 10 01		BPL	RPROD
066E 38		SEC	
066F 76 50	RPROD	ROR	PROD,X
0671 CA		DEX	
0672 10 FB		BPL	RPROD
0674 28		PLP	
0675 C6 02		DEC	MBIT
0677 D0 A4		BNE	NXTBT
0679 A6 20	RMPLR	LDX	N
067B CA		DEX	
067C 76 30	RBYTE	ROR	MPLR,X
067E CA		DEX	
067F 10 FB		BPL	RBYTE
0681 60		RTS	

Partial product negative?
No. Continue with Carry = 0
Yes. Set Carry = 1
Rotate product right

Retrieve Carry from stack
Multiplier fully processed?
No. Loop for next bit
Yes. Rotate multiplier right

of the current multiplier bit in bit 7 and the value of the previous multiplier bit in bit 6. These particular bits were selected because they're readily accessible with the 6502's BIT instruction, which puts bits 7 and 6 into the status register's N (Negative) and V (Overflow) flags, respectively.

Example 5 shows a subroutine that follows Fig. 5's flowchart to multiply two 16-bit signed numbers. Similarly, Example 6 shows a subroutine that multiplies two multiprecision signed numbers, an N-byte multiplier and an M-byte multiplicand. Note that Examples 5 and 6 represent the signed multiplication counterparts of the unsigned multiplication subroutines in Examples 3 and 4, respectively. And, incidentally, there's no reason you could not use the subroutines in Examples 5 and 6 to multiply unsigned numbers as well as signed numbers. Booth's Algorithm is applicable to either type of data, and if your multiplier contains long strings of 1's, the longer Booth's Algorithm program will probably perform an unsigned multiplication faster than the "add-and-shift" algorithm program. ■

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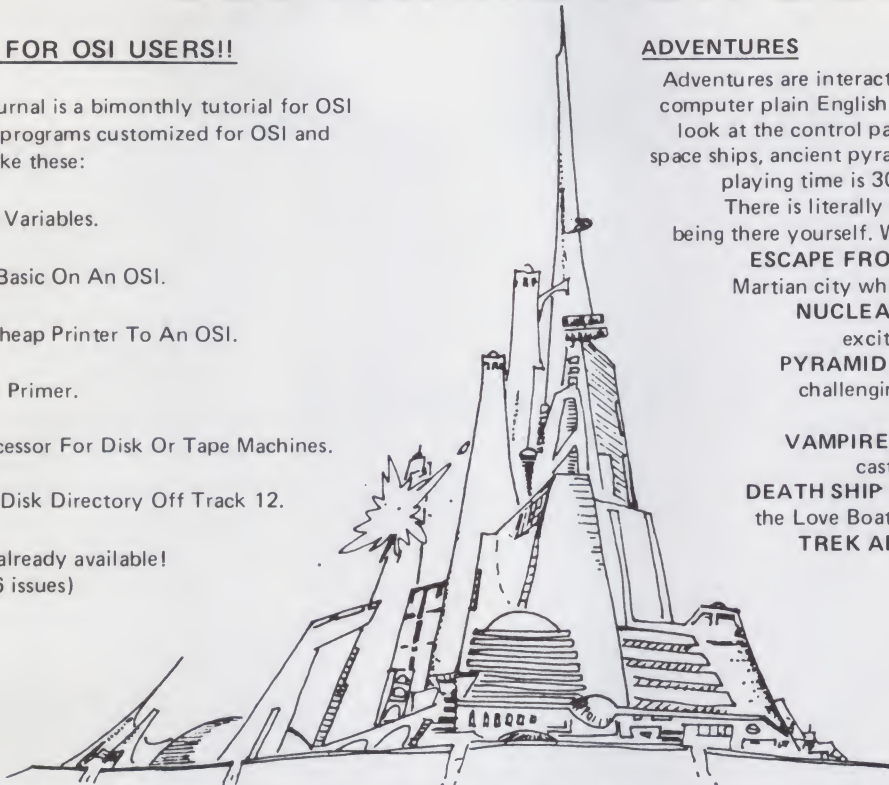
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On Guard

By Robert M. Hirbernik

If you are an Apple II owner who has been constantly plagued with accidental resets, this circuit will bring you much relief. It simply plugs into the Apple's keyboard connector and is easily removed should the Apple ever require service.

Every time you want to reset the computer, you must press and hold down reset and press ESC.

Circuit Description

The circuit continually monitors

the keyboard data lines for the ESC code. Three NAND gates invert bits three, six and seven, which are normally low for ESC, before reaching the eight-input NAND gate. Bits one, two, four and five, which are normally high for ESC, pass directly to the eight-input NAND gate.

The RES line, which goes low whenever RESET is pressed, is inverted before reaching the eight-input NAND gate. The STROBE line, which goes high after any key is

pressed, is also connected to the eight-input NAND gate, which guarantees that ESC was pressed *after* reset. Thus, when reset is held down and ESC is pressed, all lines reaching the eight-input NAND gate will be high. The output of the NAND gate then goes low, forcing the RES line low and resetting the computer.

You will notice that a two-input AND gate is used with the eight-input NAND gate because a nine-input NAND gate is required. Another two-input AND gate is used to prevent the ESC code from actually entering the Apple while the Reset-ESC sequence is being used. A 0.1 μ F capacitor is used to decouple the 5 V line to ground.

I built the reset guard on a small perfboard using sockets for the ICs. I used two 16-pin sockets, one for Apple's keyboard connector and one for a DIP ribbon cable jumper which connects to Apple's main board keyboard socket. I mounted the unit on the right-hand side of the Apple's case with adhesive mounting strips.

Once you start using this inexpensive (under \$10) mod, you will wonder how you ever got along without it. ■

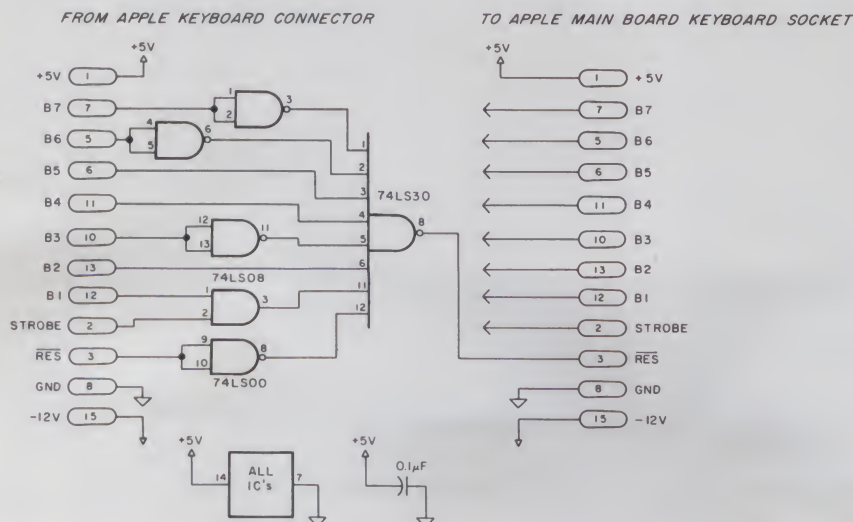
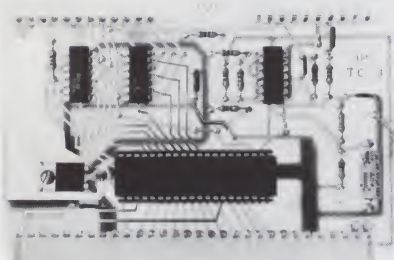


Fig. 1.

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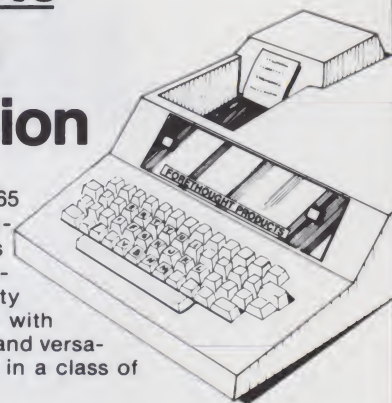
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The S-50 Bus

By Peter A. Stark

A number of S-50 bus-compatible manufacturers have banded together to spread the word: "Take the S-50 Bus—the Choice is Great!"

It all started at the West Coast Computer Faire in the spring of 1980, when several S-50 bus manufacturers and dealers happened to have adjacent booths. It grew some more at the Philadelphia Computer Show last summer, when 15 S-50 exhibitors gathered together to share a large area of the show set aside only for the S-50 bus. And now there is talk not only of bigger joint shows, but also perhaps even of joint traveling exhibits and joint advertising.

"The time has come," says Richard Don, vice-president of Gimix, Inc., the organizer of the joint gathering at the Philly show and manufacturer of 6800 and 6809 systems on the S-50 bus, "for us to stand up and tell the world we not only exist, but can also offer users just as much as any other bus—if not more.

"People assume that the S-100 bus is better because there are more manufacturers on it. But many of these manufacturers define the bus lines differently resulting in many S-100 buses, while there is only one S-50 bus," he continues. "The S-50 takes second place to no one with the latest state of the art cards. We at Gimix constantly get calls from S-100 users who want to know why we don't make S-100 versions of boards such as our programmable character set video board, or our processor board with an arithmetic processor on it—

cards that aren't even available on the S-100 bus. The S-100 may have more software, but S-50 has better development software, and with the 6809 should generate more application packages in the near future."

S-50—The Underdog

Just as the S-100 bus started with one company—Mits/Altair—so did the S-50 bus. It was developed by Southwest Technical Products, Inc. (SWTP), for their 6800-based computer.

Whereas Mits was soon followed by Imsai and others, SWTP had the bus to themselves for a year or two. This had a very important result. When other companies jumped on the S-100 bandwagon, bus standards were very loose, and each company had slightly different ideas about how best to design their equipment. The result was a variety of products which often did not work together. This incompatibility led to the creation of an IEEE standard for future S-100 products.

On the S-50 bus, on the other hand, SWTP was king, and so every company that followed with products for the bus made sure that its products were compatible. As a result, virtually every piece of 6800 hardware or software designed to work on the bus would work with everything else. SWTP ads at the time were pushing the idea that S-50 bus users were bored—they did not have all the problems that users of other systems had.

S-50 hardware and software were both much less expensive than the competition, but this led to a prob-

lem. There was a 6800 BASIC which was good as well as cheap—\$5 for the 4K BASIC, \$10 for the 8K BASIC, almost unheard of prices. Both were excellent BASICs, with ten-digit precision and many other features. And they were reliable. But they were slow.

Since using BASIC was everyone's dream, each processor—and bus, since the S-50 was exclusively a 6800 bus—was judged by the speed of its BASIC. As a result, the 6800 became known as a slow processor.

This was further aggravated by the fact that, because of their design, the 8080 and Z-80 needed faster clocks than a 6800. Even though a 6800 could do as many instructions per second at its 1 MHz clock speed as an 8080 running twice as fast, the numbers game had everyone believing that the 1 MHz 6800 was slower than a 2 MHz 8080.

When Microsoft's 6800 BASIC became available, its users suddenly discovered that this BASIC was even faster than the same BASIC on an 8080, or even the 6502.

But not until Technical Systems Consultants appeared with their 6800 BASIC—which turned out to be the fastest BASIC on any eight-bit processor anywhere—did other users learn that the 6800 was much faster than people had thought. But the damage had been done. The 6800 and, by implication, the S-50 bus had become second best.

Enter the 6809

Suddenly, there is the 6809. Those who know it love it. It's fast, it's powerful enough even for the big-time

Strikes Back!

multiprogramming, multitask users, and it's still simple to use and understand. There are systems with as little as 4K of memory, and there are systems with 384K of RAM, 16 megabytes of disk, and umpteen simultaneous users.

And it's all still on the S-50 bus. Oh yes, there have been some minor changes, but suddenly—voilà—the S-50 bus serves both the little guy and the big guns. (When SWTP started, they sold a 2K memory board. Now 64K RAM cards are common, and even a 128K RAM card is available. Just three of those make a 384K system that rivals many minis.)

It doesn't end with the 6809, of course. Though it is the most powerful eight-bit processor yet, plans are already underway to produce 68000 systems on the S-50 bus this year. With the advent of this new Motorola processor, the S-50 bus will have 16-bit computing on a macro scale.

The Variety Is There

You can get a good idea of what's available for the S-50 bus just by glancing at the wares shown at the Philadelphia Computer Show. Here is a quick summary (full names and addresses of S-50 manufacturers are listed at the end of this article).

Thomas Instrumentation was showing off its motherboards, CPU board, I/O boards and especially its new modem card.

Sirius Systems was there to assess interest in its new hard-disk controller.

Control Systems, Inc., was showing its UCSD Pascal system, complete with Pascal compiler and oper-

ating system.

Universal Data Research was demonstrating a database management system and application packages for a variety of business applications.

Sonex Systems was showing its Stylograph text editor and processor system, which provides proportional spacing, underlining, half-spacing and more.

Kenyon Microsystems was demonstrating its Forth language and supporting software for implementing this interesting language.

Gimix had the largest booth, which featured complete 6800 and 6809 systems, mainframes, CPU and memory boards, as well as all kinds of I/O equipment. Most interest was shown in their new graphics board and disk controllers.

Microware was demonstrating its new BASIC and an operating system which drew oohs and aahs from those interested in multitasking even on small systems.

Star-Kits (and yours truly) was there, showing a 6802 computer, as well as assorted S-50 bus hardware, software and firmware.

68 Micro Journal sold subscriptions and past issues of their all-68xx magazine.

Hazelwood Computer Systems was demonstrating a new 256×256 graphics card with some quite impressive features.

Frank Hogg Dental Laboratory was there with several new software items, including games, utilities and a job stream control language.

The febe group (with a lowercase 'f') showed a low-priced mainframe especially for hobbyists or others for

whom a compact, low-cost system is attractive.

Alford and Associates demonstrated a screen editor called SCREDITOR for text editing and processing.

Finally, HHH Enterprises was demonstrating its Spirit language system, as well as various other services.

But Wait . . . There's More

Though the idea of 15 S-50 bus manufacturers getting together and sponsoring a joint exhibit at a major show—complete with talks and user seminars—is unusual enough, it is important to note that even this represented just a small part of the activity on the S-50 bus.

To try to list the products available for the bus would take pages. Here, though, is a quick summary of who makes what; complete names and addresses for all the manufacturers are given at the end of this article.

S-50 mainframes: febe, Gimix, Midwest Scientific, Smoke Signal, Southwest Technical Products.

Motherboards: F&D, febe, Gimix, Midwest Scientific, Percom, Quality, Smoke Signal, Southwest Technical Products, Thomas.

6800 CPU boards: Gimix, Midwest Scientific, Thomas.

6802 CPU boards: F&D, Percom.

6809 CPU boards: F&D, Gimix, Percom, Smoke Signal, Southwest Technical Products.

RAM memory boards: American, Digital Research, Digital Service,

Associate editor Pete Stark (PO Box 209, Mt. Kisco, NY 10549) writes extensively on 68xx systems for *Kilobaud Microcomputing*.

Gimix, Midwest Scientific, Smoke Signal, Southeastern Microsystems, Southwest Microsystems, Southwest Technical Products, Wimberly, Boaz, Roberts, Hazelwood.

ROM memory boards: Gimix, Micro Works, Southwest Technical Products, Wimberly.

EPROM programmers: Micro Technical Products, Micro Works, Optimal Technology, Southwest Technical Products.

Disk controllers: F&D, Gimix, Midwest Scientific, Peripheral Technology, Smoke Signal, Southwest Technical Products.

Serial I/O: F&D, Gimix, Midwest Scientific, Quality, Southwest Technical Products, Star-Kits.

Parallel I/O: F&D, Gimix, Midwest Scientific, Quality, Southwest Technical Products, Star-Kits, Thomas.

Video boards: F&D, Gimix, Johnson, Percom, Smoke Signal, Thomas.

Graphics boards: Gimix, Hazelwood, Peripheral Technology.

Other I/O boards (such as modems, TV digitizers, A/D converters, prototyping boards and clocks): Avidd, Computer Systems Center, F&D, Gimix, Innovative Technology, JPC, Micro Works, Midwest Scientific, Newtech, Percom, Robertson, Sirius Cybernetics, Thomas, Transition Enterprises, Computerware, Alford, Windrush, Southeastern.

Disk operating systems: Blue Hat, Cer-Comp, Hemenway, Microware, Midwest Scientific, Percom, Smoke Signal, Software Dynamics, Technical Systems Consultants.

Language systems (compilers and interpreters):

- BASIC—Computerware, Microware, Microsoft, Midwest Scientific, Percom, Smoke Signal, Software Dynamics, Technical Systems Consultants.

- COBOL—Smoke Signal, Technical Systems Consultants.

- Forth—Kenyon.

- Fortran—Smoke Signal.

- Lisp—Microware.

- Pascal—Control Systems, Dynasoft, Lucidata, Phillips, Technical Systems Consultants, Omegasoft, Tallgrass.

- Pilot—Southwest Technical Products, Micropi.

- Spirit—(a Forth-type language)—HHH.

- SPL/M—Programma.

- Strubal—Hemenway.

Assemblers: Cer-comp, Cincitek, Great Plains, Hemenway, Microware, Percom, Software Dynamics, Technical Systems Consultants.

Text editors: AAA, Alford, Cer-comp, Micropi, Microware, Midwest Scientific, Percom, Programma, Sonex, Southwest Technical Products, Software Dynamics, Technical Systems Consultants.

Text processors: AAA, Midwest Scientific, Programma, Sonex, Technical Systems Consultants.

Disassemblers: Computer Systems Center, Great Plains.

ROM monitors: F&D, Gimix, Great Plains, Microware, Midwest Scientific, Percom, Sansaska, Sonex, Southwest Technical Products, Star-Kits, Thomas, Technical Systems Consultants.

Other systems software: AAA, Cincitek, Computer Systems Center, Computerware, Hemenway, Frank Hogg, LSI, Microware, Midwest Scientific, Ripley, Southwest Technical Products, Star-Kits, Technical Systems

Consultants.

Application programs: AAA, Applevalley, Computerware, DP Systems, Great Plains, Magnusen, Midwest Scientific, Mycroftware, Omnitronics, Schiele, Star-Kits, Technical Systems Consultants, Universal Data, Washington Computer, Westchester.

Games: Alford, Computerware, Frank Hogg, Microware, Star-Kits, Technical Systems Consultants, Mark, Application.

Magazines: 68 Micro Journal, S-50 Newsletter. (And, of course, *Kilobaud Microcomputing*, which regularly features articles on S-50 systems.)

Expandability and Low Price

S-50 systems traditionally have a ROM monitor which replaces a front panel, permitting all the operations which a front panel might otherwise perform (and more), but from a CRT terminal or teleprinter. The need for a terminal seemed like an additional expense at the beginning, especially as compared to the all-in-one appliance computers.


But now a number of manufacturers offer video boards which, along with an inexpensive keyboard, replace the terminal and provide even faster operation. This brings S-50 systems down in price to match even the appliance computers.

The key is expandability. A starter system of the appliance class, such as a TRS-80 or PET, can be cheaper than an equivalent S-50 system. But since S-50 systems are easily—and inexpensively—expanded, a moderate size S-50 system can be much more economical than a moderate system of the appliance class. Moreover, the bus/motherboard concept makes all the accessories fit inside one cabinet, instead of being spread around in expansion adapters and connected with a mass of cable. The result is a more reliable and efficient system as well.

So when you look at system buses, consider the S-50 bus. It has a lot going for it. ■

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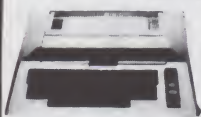
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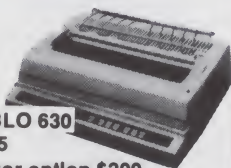
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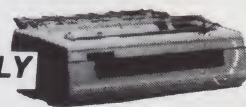


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Dump It on Cassette

By Colin Macauley

After fooling about with your new AOSI Challenger 1P or Superboard II in BASIC, you may wish to consider an alternative. Have you ever answered "M" to the "D/C/W/M?" prompt when the machine is turned on and the break key hit? Not many have, judging from the lack of machine-language articles found in the magazines.

If you don't know the difference between an accumulator and a register, some preliminary reading will be required (see first reference). Otherwise, shame on you for not fully using your machine. To appreciate the instruction set of the 6502, its advantages and limitations, I suggest perusal of the classic textbooks (see references).

The three pages devoted to machine language in the OSI User's Manual may be devastating and may be the reason you have never tried it

before. The following commands are at your disposal:

Address Mode Commands

/—Change to Data Mode.
G—Commence execution of program at address shown on screen.
L—Load memory from audio cassette.

Data Mode Commands

●—Change to Address Mode.
"RETURN"—Increment memory address shown on screen.

From these commands you will note that the OSI machine-language monitor is very basic and has a striking anomaly. You can load from cassette, but there is no command to let you dump your program to cassette.

The program listing shows how to save your machine-language programs on tape. The program is located at \$1B60, but may be located at any convenient address if the lines with asterisks are altered to suit your address changes. The following zero-page addresses are used:

\$F0—START—low byte of starting address of program to be saved.
\$F1—START+1—high byte of above starting address.

\$F2—END—low byte of the end address of program to be saved.
\$F3—END+1—high byte of above end address.
\$F4—TEMP—
\$F5—TEMP+1— working variables.
\$F6—COUNT—counter variable.

The data for memory locations \$F0 through \$F3 must be entered before saving a program.

The operation of the program is very simple. The data is converted to ASCII and then dumped to cassette via the Motorola 6850 ACIA. Additional comments for the program lines are provided in Table 1.

To demonstrate the program, type in the hexadecimal listing commencing at location \$1B60. Enter starting address of program in zero-page; i.e., \$00F0 contains \$60 and \$00F1 contains \$1B (always remember that the low address byte is stored first in 6502 assembly language). Similarly, the end address is entered; i.e., \$00F2 contains \$32 and \$00F3 contains \$1C. Turn your recorder on and run the program by entering ".1B60G". The dump is completed when the screen indicates a return to the monitor by displaying \$0000. ■

References

- Osborne, Adam. *An Introduction to Microcomputers*. Osborne/McGraw-Hill. Volumes 0 and 1.
Zaks, Rodney. *Programming the 6502*. Sybex.
Leventhal, L. A. *6502 Assembly Language Programming*. Osborne/McGraw-Hill.

Address correspondence to Colin Macauley, c/o Callinan and Associates, PO Box 238, East Melbourne, Victoria 3002, Australia.

01-04	—Initialize ACIA (\$F000, \$F001).
05-12	—Dump address "header" to cassette.
13-19	—Check whether more than one page is to be dumped. Go to LESS if less than one page involved.
20-43	—Dump whole pages to cassette and jump to REST when complete.
44-47	—Less than one page to be dumped.
48-66	—Dump remainder of incomplete page or, if less than one page, dump whole program.
67-79	—Dump address "footer" (which enables return to monitor) to cassette.
80-97	—Converts a byte to ASCII and dumps ASCII to cassette.
98-105	—Checks that ACIA is ready to transmit and dumps ASCII to cassette.

Table 1. Program line comments.

Address	Instruction	Comment	Register
01	LDA #03		A9,03
02	STA \$F000		8D,00,F0
03	LDA #B1		A9,B1
04	STA \$F000		8D,00,F0
05	LDA " "		A9,2E
06	JSR PUNCH		20,26,1C
07	LDA START+1		A5,F1
08	JSR ASCII		20,0B,1C
09	LDA START		A5,F0
10	JSR ASCII		20,0B,1C
11	LDA "/"		A9,2F
12	JSR PUNCH		20,26,1C
13	CLD		D8
14	SEC		38
15	LDA END		A5,F2
16	SBC START		F5,F0
17	LDA END+1		A5,F3
18	SBC START+1		F5,F1
19	BEQ LESS		F0,32
20	TAX		AA
21	LDA START		A5,F0
22	STA TEMP		85,F4
23	LDA START+1		A5,F1
24	STA TEMP+1		85,F5
25	LDY #00		A0,00
26	LDA #00		A9,00
27	STA COUNT		85,F6
28	LDA (TEMP),Y		B1,F4
29	JSR ASCII		20,0B,1C
30	LDA "CR"		A9,0D
31	JSR PUNCH		20,26,1C
32	INC TEMP		E6,F4
33	BNE COUNT		D0,02
34	INC TEMP+1		E6,F5
35	INC COUNT		E6,F6
36	LDA #00		A9,00
37	CMP COUNT		C5,F6
38	BEQ NEXTPAGE		F0,03
39	JMP LOOP		4C,99,1B
40			
41	DEX #00		CA
42	BEQ REST		E0,00
43	JMP REDO		F0,0B
44	LDA START		4C,95,1B
45	STA TEMP		A5,F0
46	LDA START+1		85,F4
47	STA TEMP+1		85,F5
48	LDA END		A5,F2
49	SEC		38
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Number Squares

By Marc I. Leavey

It all started when my five-year-old daughter returned from a birthday party with a small plastic square with a four-by-four grid, in which there are 15 numbered tiles and one blank square. The object of this number squares game is to move the tiles one at a time until they are in the desired order. It may not seem like much, but it's fun, and it even had me going for a while.

Did I say it "had me going"? That was the problem—I was becoming addicted. What makes the game so intriguing is that you can only move one tile at a time. It wasn't long, though, before I duplicated the game on my CRT.

In the computer version, the board is represented by a four-by-four array. Shifting a tile into the solitary blank space is the only legal move. The number of the piece to be moved is thus the player input.

The computer checks to see if the piece input is next to a space and, if it is, moves the piece. Moves continue

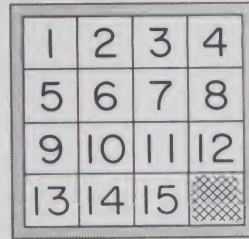


Fig. 1. One sequential solution to Number Squares.

until the pieces are in the desired order, at which time a win is declared.

To set up the program, a four by four array is established and sequentially filled with the integers one through 16. The blank is represented by 16, and resides at the lower right.

Next, the board is scrambled by randomly moving the blank 200 times. Each move is up, down, left or right, and, after 200 random moves, the board is quite a mess.

It is important to realize the board is not randomly filled with numbers.

If it were, there might be no solution to the puzzle. Instead, the board is scrambled just as a real one is, by starting with a correct setup, and then moving pieces randomly—by the rules—to clear the board.

Once the board is initialized, it is displayed on the screen, and a user input is requested.

The input number is checked for range and validity of movement. If all is in order, the input piece is moved into the blank, and the blank into the position of the input piece. Remember, only vertical or horizontal moves are allowed; no diagonals are permitted.

After each move, the order of the board is scanned and, if in proper order, a win is declared.

But what is the proper order? As originally conceived, a player wins when the tiles are in numerical order (Fig. 1). However, another solution is possible. In the Magic Square, every column and row adds up to 30. In the interest of a more challenging game, I will not provide a diagram of the Magic Square solution. It is available in the program if you look for it, but not knowing it exactly makes the game that much more fun.

I set up the display of the game for a terminal running at 1200 baud, with homing and erasing capabilities. With some creative programming and a VDM, quite a nice display can be constructed and inserted in place of the display module in the program. No fancy features of any special BASIC were used, and the program

Number Squares program listing.

```
0010 : NUMBER SQUARE GAME
0020 : VER 4.0 - 12 NOV 79
0030 : MARC I. LEAVEY, M.D.
0040 LINE= 0
0050 DIGITS= 0
0060 PRINT "NUMBER SQUARES"
0070 PRINT "-----"
0080 PRINT
0090 PRINT "WELCOME TO THE WORLD OF"
0100 PRINT "CONFUSION. THERE ARE TWO"
0110 PRINT "VERSIONS OF NUMBER SQUARES:"
0120 PRINT " 1 - SEQUENTIAL"
0130 PRINT " 2 - MAGIC SQUARE"
0140 INPUT "WHICH IS YOUR PLEASURE",T
```

More →

Marc I. Leavey, M.D., 4006 Winlee Road, Randallstown, MD 21133.

Program listing continued.

```

0150 IF T=1 GOTO 310
0160 IF T<>2 GOTO 140
0170 :
0180 : SET UP MAGIC
0190 : SQUARE BOARD
0200 :
0210 FOR I=1 TO 4
0220 FOR J=1 TO 4
0230 READ M(I,J)
0240 LET B(I,J)=M(I,J)
0250 NEXT J
0260 NEXT I
0270 DATA 1,6,15,8,12,11,2,5,10,13,4,3,7,16,9,14
0280 LET I1=4
0290 LET J1=2
0300 GOTO 440
0310 :
0320 : SET UP SEQUENTIAL
0330 : BOARD
0340 :
0350 DIM B(4,4)
0360 FOR I=1 TO 4
0370 FOR J=1 TO 4
0380 LET B(I,J)=(I-1)*4+J
0390 NEXT J
0400 NEXT I
0410 LET I1=4
0420 LET J1=4
0430 :
0440 : NOW SCRAMBLE THE BOARD
0450 : TWO HUNDRED TIMES
0460 :
0470 PRINT "I AM NOW SCRAMBLING THE BOARD..."
0480 FOR Q=1 TO 200
0490 LET M=INT(1+RND*4)
0500 ON M GOTO 510,560,610,660
0510 IF I1=1 GOTO 490
0520 LET B(I1,J1)=B(I1-1,J1)
0530 LET B(I1-1,J1)=16
0540 LET I1=I1-1
0550 GOTO 700
0560 IF I1=4 GOTO 490
0570 LET B(I1,J1)=B(I1+1,J1)
0580 LET B(I1+1,J1)=16
0590 LET I1=I1+1
0600 GOTO 700
0610 IF J1=1 GOTO 490
0620 LET B(I1,J1)=B(I1,J1-1)
0630 LET B(I1,J1-1)=16
0640 LET J1=J1-1
0650 GOTO 700
0660 IF J1=4 GOTO 490
0670 LET B(I1,J1)=B(I1,J1+1)
0680 LET B(I1,J1+1)=16
0690 LET J1=J1+1
0700 NEXT Q
0710 :
0720 : PRINT BOARD
0730 :
0740 LET M9=0
0750 : OUTPUT A "HOME UP"
0760 PRINT CHR$(16);
0770 PRINT "-----"
0780 FOR I=1 TO 4
0790 FOR J=1 TO 4
0800 PRINT " ";
0810 IF B(I,J)=16 PRINT " ";:GOTO 840

```

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should run on any machine.

This is not a complicated program, but it shows methods of array handling and move checking. Display formatting and concern for screen readability are also factors.

The game itself is addicting. If you want to make it easier at first, change the setup scramble in line 480 to loop to 50 instead of 200, or make the loop variable and allow the user to choose his own degree of difficulty. A sample routine might be:

```
0480 INPUT "DEGREE OF DIFFICULTY
(10-500);" Q9
0485 FOR Q=1 TO Q9
```

Try it. And if you've got a little girl around five, don't blame me if she takes over. Mine did! ■

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Program listing continued.

```
0820 IF B(I,J)<10 PRINT " ";
0830 PRINT B(I,J);
0840 NEXT J
0850 PRINT ":"
0860 PRINT "-----"
0870 NEXT I
0880 :
0890 : ERASE REST OF SCREEN AND
0900 : BEEP FOR INPUT
0910 :
0920 PRINT CHR$(22);CHR$(7);CHR$(7);
0930 :
0940 : INPUT MOVE
0950 :
0960 INPUT "MOVE WHICH PIECE",M
0970 LET I1=0:J1=0
0980 FOR I=1 TO 4
0990 FOR J=1 TO 4
1000 IF B(I,J)=M THEN I1=I:J1=J
1010 NEXT J
1020 NEXT I
1030 IF I1=0 THEN PRINT "I CAN'T FIND THAT NUMBER":GOTO 940
1040 LET I2=0:J2=0
1050 FOR I=I1-1 TO I1+1
1060 IF I>4 GOTO 1090
1070 IF I<1 GOTO 1090
1080 IF B(I,J1)=16 THEN I2=I:J2=J1:GOTO 1170
1090 NEXT I
1100 FOR J=J1-1 TO J1+1
1110 IF J>4 GOTO 1140
1120 IF J<1 GOTO 1140
1130 IF B(I1,J)=16 THEN I2=I1:J2=J:GOTO 1170
1140 NEXT J
1150 LET M9=M9+1
1160 PRINT "NOT A VALID MOVE":GOTO 940
1170 LET B(I2,J2)=M
1180 LET B(I1,J1)=16
1190 ON T GOTO 1210,1320
1200 :
1210 : SEQUENTIAL SOLUTION
1220 :
1230 LET C=0
1240 FOR I=1 TO 4
1250 FOR J=1 TO 4
1260 IF B(I,J)<C GOTO 720
1270 LET C=B(I,J)
1280 NEXT J
1290 NEXT I
1300 PRINT "YOU GOT IT!"
1310 GOTO 1450
1320 :
1330 : MAGIC SQUARE SOLUTION
1340 : CHECK
1350 :
1360 FOR I=1 TO 4
1370 FOR J=1 TO 4
1380 IF B(I,J)<>M(I,J) GOTO 720
1390 NEXT J
1400 NEXT I
1410 :
1420 : A WIN IS DECLARED!
1430 :
1440 PRINT "THAT IS THE CORRECT SOLUTION!"
1450 INPUT "LIKE TO PLAY ANOTHER GAME",I$
1460 IF LEFT$(I$,1)="Y" THEN RUN
1470 END
```


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Thoughts on The 68XX Systems

By Garry O. Caudell and Ron Silver

As part of writing this continuing series on 68xx systems, I often receive suggestions on useful topics from avid fans of the 6800 and 6809. This month I'll sit back and combine two contributions from readers into an article under their name.—Pete Stark.

BASIC interpreters usually require that each line be numbered, and automatically insert new lines into line number order, thus providing a certain amount of editing capability.

It is possible to insert, delete or substitute new lines into a program by making use of the line numbers. When a program statement is no longer needed, it can be deleted

simply by entering its line number. A line can be changed by retyping a line with the same line number. And finally, a line can be inserted between two existing lines simply by using a line number that is between the values of the line numbers of those two statements.

The above features of BASIC are useful. However, in the process of writing and debugging a BASIC program, you'll often need to make minor modifications to quite a few lines. In most 6800 and 6809 BASICs, each of these modifications requires that you retype the entire line, even when only one or two characters need to be changed.

On disk systems, users often resort

to the text editor to make such changes. Yet it is possible to overcome this limitation of the BASIC interpreter by adding to it a more powerful edit function. This modification would make the BASIC system easier to use by letting the user edit a line without retyping the whole line.

Many other computers (such as the TRS-80) have such editing capability in their BASIC, since not much additional code is required.

This article presents the modifications to implement this editing function in SWTP 8K BASIC versions 2.0 and 2.2 (see Listing 1), SWTP Disk BASIC version 3.5 (Listing 2) and Percom Super BASIC (Listing 3).

Although there are differences in the three implementations, the idea is the same. In fact, it is also easily applied to the TSC Text Editor itself (see Listing 4, and further details later). Although the TSC Text Editor provides many ways of editing entire lines, its provisions for manipulating characters within a line are somewhat awkward. This modification fixes that problem.

What It Does

To implement this feature, you must use a CRT terminal. The modification dynamically shows each edit-

Control Character	ASCII Code	Function
Control-E	\$05	Enters edit mode—may be used during any input.
Control-R	\$12	Recalls a line from memory for editing. The line recalled will be the line whose line number appears at the beginning of the line being typed when control-R is entered.
Control-A	\$01	Adds a space at cursor position.
Control-D	\$04	Delete character at cursor position.
Control-H	\$08	Backspace—move cursor left.
Control-I	\$09	Tab—move cursor right.
(CR)	\$0D	Carriage return—enters the line into memory as if it had just been just typed in, regardless of cursor position.

Table 1. Summary of edit commands.

Address correspondence to Ron Silver, Kelvin High School, 155 Kingsway Ave., Winnipeg, Man-

ing change as it occurs by rapidly spacing forward or backward to erase and rewrite the changed line. Since most teleprinters do not backspace, this would not work on such a terminal; even with backspacing, it would repeatedly overprint a line and produce a black mess.

The modified BASIC interpreter lets the user insert, delete or change any character in any statement of a program. The edit functions are controlled by six control keys.

BASIC program entry and editing is unaffected until a control-E (\$05 code) is typed. This causes a branch to the edit subroutine in the patch. This subroutine then processes all succeeding characters and commands entered from the keyboard until hitting the carriage return returns back to normal BASIC entry.

Editing occurs on the line currently in BASIC's input buffer. If a line is being entered, then that line will be edited. This mode, however, is probably not that useful, since in many cases it is easier to simply backspace to the wrong character and retype from there.

A far more powerful feature of this editor modification is its ability to recall lines previously entered. Typing the number of this line followed by control-E to enter the editor, and then control-R to recall the line, brings a line from memory back into the buffer for editing. The line now appears on the CRT as if it had just been typed, and the cursor is positioned at the end of the line.

At this point, the cursor would normally be moved to the character where a change is to be made.

Backspace (control-H) moves the cursor back to the left without erasing the characters it is stepping over.

Horizontal tab (control-I) moves the cursor to the right, again without erasing the characters it is stepping over.

Once the cursor is positioned where a change is wanted, there are three ways to proceed:

Control-A inserts (adds) a space at the current cursor position and moves the following characters one place to the right. On a slow terminal you can see the rest of the line being rewritten; on a fast terminal (9600 baud, for example) this occurs so fast that it is nearly invisible.

Listing 1. Editing modification in SWTP 8K BASIC versions 2.0 and 2.2.

```

00010                                     NAM  EDITOR
00015                                     OPT  O
00016                                     * BASIC ENTRY POINTS
00020      0485      PSHX  EQU  $0485      PUSH INDEX
00030      00B0      BUFFER EQU  $B0        BEGINNING OF THE BASIC BUFFER
00035      00F8      BUFEND EQU  $F8        END OF BUFFER
00040      0440      BERROR EQU  $0440      ERROR ROUTINE
00050      0395      INPUTC EQU  $0395      INPUT ROUTINE
00060      0386      OUTC  EQU  $0386      OUTPUT ROUTINE
00070      049A      PULX  EQU  $049A      PULL INDEX
00080      004A      COUNTR EQU  $4A
00085      0024      BUFNT EQU  $24        POINTER TO BUFFER POSITION
00086      002C      MEMPNT EQU  $2C        POINTER TO MEMORY POSITION
00087      00AC      TEMP  EQU  $AC
00090      0AC7      BERR2 EQU  $0AC7      ERROR ROUTINE
00100      0ACA      NUMC  EQU  $0ACA      NUMERIC CONVERSION
00110      0A87      LINEC EQU  $0A87      FIND LINE IN MEMORY
00120      0467      PSTR  EQU  $0467      PRINT STRING ROUTINE
00130      0453      PLINEC EQU  $0453      BRANCH POINT BACK TO BASIC
00132                                     * MISC CONSTANTS
00133      0008      BACK  EQU  $08        BACK SPACE CHARACTER
00134      0009      TAB  EQU  $09        FORWARD TAB CHARACTER
00140      IEAF      BD  0485      EDIT  JSR  PSHX
00150      IEAF      BD  0485      EDIT  JSR  PSHX
00160      IEB2      6F 00      CLEAR  CLR  ,X      CLEAR BUFFER TO END
00170      IEB4      08      INX
00180      IEB5      8C 00F8      CPX  #BUFEND      IS IT THE END OF THE BUFFER?
00190      IEB8      26 F8      BNE  CLEAR
00200      IEBA      BD  049A      JSR  PULX
00210      IEBD      BD  0395      INPUT JSR  INPUTC      INPUT LOOP
00220      IEC0      81 0D      CMP  A  #0D      CHECK FOR CARRIAGE CONTROL
00230      IEC2      26 03      BNE  CONT1
00240      IEC4      7E 1FBD      JMP  ENDRTN      IF SO JUMP BACK TO BASIC
00250      IEC7      81 08      CONT1 CMP  A  #BACK      CHECK FOR BACKSPACE
00260      IEC9      27 2D      BEQ  BACKSPC
00270      IECB      81 09      CMP  A  #TAB
00280      IECD      27 15      BEQ  FORWARD
00290      IECF      81 04      CMP  A  #04      CONTROL D
00300      IED1      27 34      BEQ  DELETE
00310      IED3      81 01      CMP  A  #01      CONTROL A
00320      IED5      27 5D      BEQ  ADD
00330      IED7      81 12      CMP  A  #12      CONTROL R
00340      IED9      26 03      BNE  CONT3
00350      IEDB      7E 1F52      JMP  RECALL
00360      IEDE      81 1F      CONT3 CMP  A  #1F      CHECK IF CONTROL CHARACTER
00370      IEE0      2B DB      BMI  INPUT      IF SO IGNORE
00380      IEE2      A7 00      STORCH STA A ,X      STORE CHARACTER IN BUFFER
00385                                     * MOVE CURSOR FORWARD
00390      IEE4      A6 00      FORWAR LDA A ,X
00395                                     * CHECK IF AT END OF LINE IN BUFFER
00400      IEE6      26 07      BNE  CONT2      BRANCH IF NOT
00410      IEE8      86 08      LDA  A  #BACK
00415                                     * PUT CURSOR BACK WHERE IT BELONGS
00420      IEEA      BD  0386      JSR  OUTC

00430      IEED      20 CE      BRA  INPUT
00435                                     * MOVE TO NEXT POSITION IN BUFFER
00440      IEEF      08      CONT2 INX      MOVE TO NEXT POSITION IN BUFF
00450      IEF0      8C 00F8      CPX  #BUFEND      CHECK FOR END OF BUFFER
00460      IEF3      26 C8      BNE  INPUT
00470      IEF5      7E 0440      ERROR JMP  BERROR
00475                                     * BACKUP CURSOR
00480      IEF8      8C 00B0      BACKSP CPX  #BUFFER      CHECK IF AT START OF BUFFER
00490      IEFB      27 03      BEQ  ATBEG      BRA IF SO
00500      IEFD      09      DEX
00510      IEFE      20 BD      LOOPBA BRA  INPUT
00520      IF00      86 09      ATBEG LDA A #TAB      MOVE CURSOR FORWARD
00530      IF02      BD  0386      JSR  OUTC
00540      IF05      20 B6      BRA  INPUT

00547                                     * DELETE A CHARACTER FROM BUFFER AND CRT
00550      IF07      BD  0485      DELETE JSR  PSHX
00555                                     * ZERO COUNTER IN ORDER TO REPOSITION CURSOR
00560      IF0A      7F 004A      CLR  COUNTR
00565                                     * MOVE CURSOR AND BUFFER CONTENTS ONE POSITION LEFT
00570      IF0D      A6 01      MOVLEF LDA A ,X
00580      IF0F      BD  0386      JSR  OUTC
00590      IF12      A7 00      STA  A  X
00600      IF14      08      INX
00610      IF15      7C 004A      INC  COUNTR      COUNT CHARACTERS TO END
00620      IF18      4D      TST  A
00630      IF19      26 F2      BNE  MOVLEFT
00640      IF1B      86 20      SPACE LDA A #20      PRINT SPACE
00650      IF1D      BD  0386      JSR  OUTC
00655                                     * PUT CURSOR BACK TO CORRECT POSITION
00660      IF20      7D 004A      MOVECS TST  COUNTR      CHECK TO SEE IF FINISHED
00670      IF23      27 0A      BEQ  ENDD
00680      IF25      86 08      LDA  A  #BACK
00690      IF27      BD  0386      JSR  OUTC
00700      IF2A      7A 004A      DEC  COUNTR
00710      IF2D      20 F1      BRA  MOVECSR
00720      IF2F      BD  049A      JSR  PULX
00730      IF32      20 CA      BRA  LOOPBACK

```

More

Listing 1 continued.

```

00740 1F34 BD 0485 ADD JSR PSHX
00746 * ADD SPACE TO BUFFER AT CURSOR POSITION
00750 1F37 7F 004A CLR COUNTR ZERO COUNTER
00760 1F3A C6 20 LDA B #320 PUT SPACE IN BUFFER
00765 * MOVE CURSOR AND BUFFER RIGHT ONE PLACE
00770 1F3C 17 MOVRT TBA
00780 1F3D E6 00 LDA B X
00790 1F3F A7 00 STA A X
00800 1F41 BD 0386 JSR OUTC
00810 1F44 08 INX
00820 1F45 8C 00F8 CPX #BUFEND CHECK FOR FILLED BUFFER
00830 1F48 27 AB BEQ ERROR
00840 1F4A 7C 004A INC COUNTR COUNT CHARACTERS FILLED
00850 1F4D 4D TST A
00860 1F4E 26 EC BNE MOVRT
00870 1F50 20 C9 BRA SPACE

00877 * RECALL LINE FROM MEMORY AND PLACE IN BUFFER
00880 1F52 8D 5B RECALL BSR ZERCSR MOVE CURSOR TO START OF LINE
00890 1F54 CE 00B0 LDX #BUFFER FIND LINE NUMBER IN BUFFER
00900 1F57 BD 0ACA JSR NUMC CONVERT TO BCD FOR LINEC
00910 1F5A 24 03 BCC CONT4 INVALID LINE NUMBER?
00920 1F5C 7E 0AC7 ERR2 JMP BERR2
00925 * STORE POSITION OF END OF LINE NUMBER
00930 1F5F DF 24 CONT4 STX BUFPT
00940 1F61 BD 0A87 JSR LINEC FIND LINE IN MEMORY
00950 1F64 25 F6 BCS ERR2 BRANCH IF NOT FOUND
00955 * SKIP PAST LINE NUMBER STORED IN MEMORY
00960 1F66 08 INX
00970 1F67 08 INX
00975 * STORE POSITION OF LINE IN MEMORY
00980 1F68 DF 2C STX MEMPT
00990 1F6A 8D 1F BSR STORKY STORE KEYWORD IN BUFFER
01000 1F6C 08 INX
01005 * TRANSFER CHARACTERS FROM MEMORY TO BUFFER
01010 1F6D A6 00 SLOOP LDA A X
01020 1F6F 4D TST A
01025 * BRANCH IF LAST CHARACTER IN LINE
01030 1F70 27 0A BEQ ENDR
01040 1F72 81 19 CMP A #319 ANOTHER KEYWORD?
01050 1F74 2C 04 BGE STRCHR BRANCH IF NOT
01060 1F76 8D 13 BSR STORKY STORE KEYWORD IN BUFFER
01070 1F78 20 F3 BRA SLOOP
01080 1F7A 8D 1C STRCHR BSR TRNSFR+2 STORE CHARACTER IN BUFFER
01090 1F7C DE 24 ENDR LDX BUFPT STORE $00 IN BUFFER
01100 1F7E A7 00 STA A X
01110 1F80 CE 00B0 LDX #BUFFER PRINT CONTENTS OF THE BUFFER
01120 1F83 BD 0467 JSR PSTR
01125 * SET INDEX TO LAST CHARACTER IN BUFFER
01130 1F86 DE 24 LDX BUFPT
01140 1F88 7E 1EBD JMP INPUT
01150 1F8B EE 00 STORKY LDX X STORE KEYWORD IN BUFFER
01160 1F8D 09 DEX
01170 1F8E 09 BACKUP DEX LOCATE KEYWORD IN TABLE
01180 1F8F A6 00 LDA A X
01190 1F91 26 FB BNE BACKUP
01195 * SKIP PAST JUMP ADDRESS IN TABLE
01200 1F93 08 INX
01210 1F94 08 INX
01220 1F95 08 INX
01230 1F96 A6 00 TRNSFR LDA A X TRANSFER CHARACTERS TO BUFFER
01240 1F98 81 20 CMP A #32 LAST CHARACTER? OR KEY WORD?
01250 1F9A 2D 0E BLT ENDSTR BRANCH IF SO
01260 1F9C 08 INX
01270 1F9D DF AC STX TEMP STORE MEMORY POINTER
01280 1F9F DE 24 LDX BUFPT PICK UP BUFFER INDEX
01290 1FA1 A7 00 STA A X
01300 1FA3 08 INX
01310 1FA4 DF 24 STX BUFPT
01320 1FA6 DE AC LDX TEMP
01330 1FA8 20 EC BRA TRNSFR
01335 * LOAD POSITION OF BUFFER AFTER LINE#
01340 1FAA DE 2C ENDSTR LDX MEMPT
01345 * LOAD POSITION OF BUFFER AFTER LINE#
01350 1FAC 08 INX
01360 1FAD 08 INX
01370 1FAE 39 RTS
01380 1FAF 8C 00B0 ZERCSR CPX #BUFFER AT BEGINNING OF BUFFER?
01390 1FB2 27 08 ENDZ BRANCH IF YES
01400 1FB4 86 08 LDA A #BACK
01410 1FB6 BD 0386 JSR OUTC
01420 1FB9 09 DEX
01430 1FBA 20 F3 BRA ZERCSR
01440 1FBC 39 ENDZ RTS

01450 1FBD CE 00AF ENDRTN LDX #BUFFER-1 FIND END OF LINE IN BUFFER
01460 1FC0 08 LOOP INX
01470 1FC1 A6 00 LDA A X
01480 1FC3 4D TST A
01490 1FC4 26 FA BNE LOOP
01500 1FC6 7E 0453 JMP PLINEC
01510 1FC9 PRGEND EQU *

```

Control-D deletes the character at the current cursor position and moves all following characters one place to the left.

The preceding edit commands are summarized in Table 1.

Alternatively, typing any other character substitutes the new character instead of the old one, and moves the cursor right one place.

This recall-and-edit feature can be used to change any part of the line, even the line number. Changing the line number makes it into a new line, to be inserted into the program in line number order. The old line stays in the program, and the new line is added. Thus it is possible to produce identical (or slightly modified) copies of existing lines.

How It Works

Let's confine ourselves to describing the version 2.0 BASIC patch in Listing 1; the other versions work similarly.

The edit patch works by manipulating characters in the BASIC interpreter buffer that starts at location 00B0.

Lines 20-130 of the program define entry points to the BASIC interpreter. PSHX and PULX are two subroutines used to push and pull the index register into an index stack kept by BASIC. INPUTC and OUTC are the BASIC character input and output routines. NUMC is a BASIC routine which converts a number in ASCII in memory to a binary-coded decimal (BCD) number used by LINEC to find that line in memory.

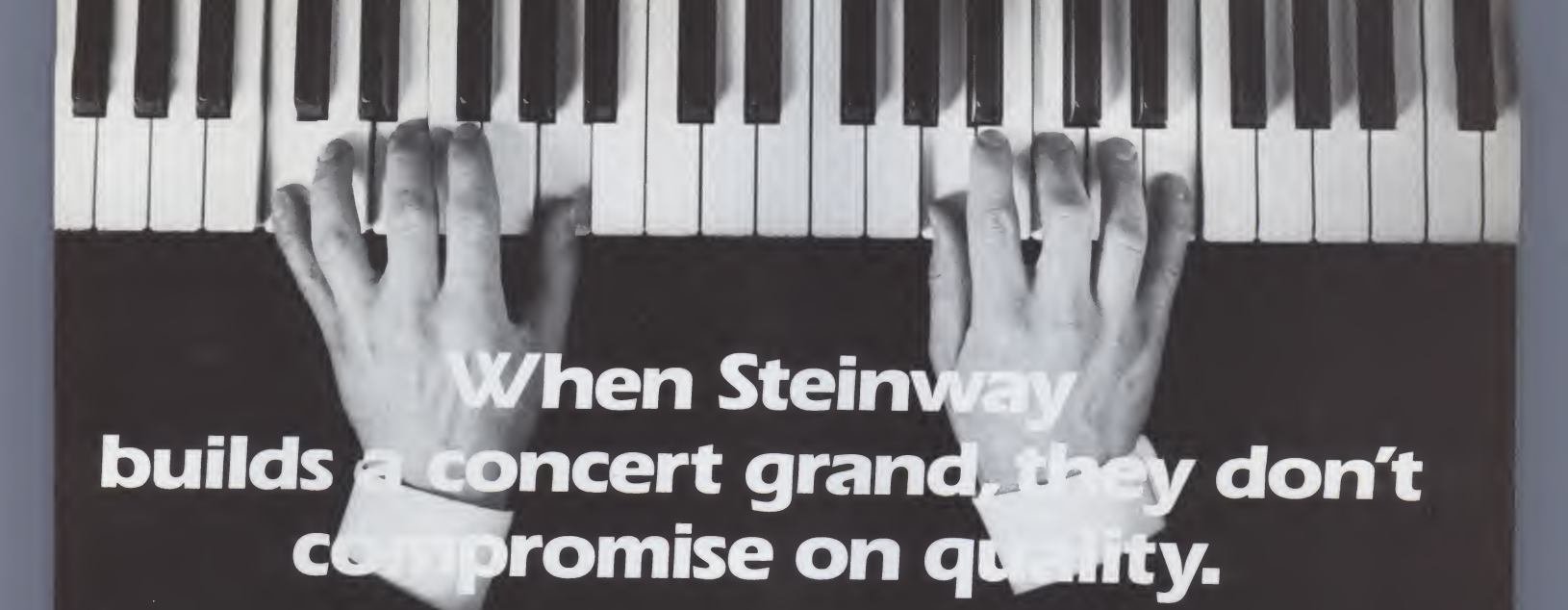
PSTR is a routine which prints a string of characters. PLINEC is the entry point when a carriage return has been entered.

Lines 150-540 represent the edit input routine, which branches to the appropriate routines when the proper control characters are entered. It starts at 1EAF for BASIC version 2.0, 1EE2 for BASIC version 2.2 or 2698 for BASIC version 3.5.

The delete routine, called with a control-D, consists of lines 550-730. MOVELF shifts all characters in the buffer which are past the cursor position one place to the left. As it does this, it prints those characters on the CRT and counts them. MOVECS then puts the cursor back to where it started by printing that number of backspaces.

The add routine, called by a control-A and shown in lines 740-879, operates in a similar manner except

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Listing 1 continued.

```

01520 040F          ORG    $040F
01530 040F 81 05    CMP A  #5
01540 0411 26 03    BNE    CONT6
01550 0413 7E 1EAF  JMP    EDIT
01560 0416 B1 0153  CMP A  $153    CHECK FOR CONTROL X
01570 0419 27 DE    BEQ    $3F9
01580 041B B1 0154  CMP A  $154
01590 041E 27 08    BEQ    CONT7
01600 0420 81 0D    CMP A  $30D    CHECK FOR CAR RETURN
01610 0422 27 2F    BEQ    PLINEC
01620 0424 2D E6    BLT    $40C
01630 0426 20 0E    BRA    $436
01640 0428 B6 0155  LDA A  $0155
01650 014E          ORG    $14E
01660 014E 1FC9     FDB    PRGEND
01665 0154          ORG    $154
01670 0154 08      FCB    BACK.0
          0155 00
01680 A048          ORG    $A048
01690 A048 0100     FDB    $100

```

Listing 2. Editing modification in SWTP Disk BASIC version 3.5.

```

00010          NAM    EDITOR
00020          *
00030          * EDITOR FOR BASIC V3.5 AS SUPPLIED FOR DMAFI DISK
00040          *
00050          * WRITTEN BY R.SILVER
00060          *
00070          * MODIFIED FOR THE DMAFI DISK BASIC BY K.J.KROEKER
00080          *
00090          *
00100          0547  PSHX  EQU    $0547
00110          04F0  BERROR EQU    $04F0
00120          0428  INPUTC EQU    $428
00130          03F1  OUTC  EQU    $3F1
00140          055C  PULX  EQU    $055C
00150          0     OPT    0.5
00160          0BA1  BERR2 EQU    $0BA1
00170          0BA4  NUMC  EQU    $0BA4
00180          0B61  LINEC EQU    $0B61
00190          0520  PSTR  EQU    $0520
00200          050C  PLINEC EQU    $050C
00210 2698          ORG    $2698
00220 2698 BD 0547  EDIT  JSR    PSHX
00230 269B 6F 00    CLEAR CLR    ,X
00240 269D 08      INX
00250 269E 8C 00F8  CPX    $00F8
00260 26A1 26 F8    BNE    CLEAR
00270 26A3 BD 055C  JSR    PULX
00280 26A6 BD 0428  INPUT JSR    INPUTC
00290 26A9 81 0D    CMP A  $30D
00300 26AB 26 33    BNE    CONT1
00310 26AD 7E 27A6  JMP    ENDRTN
00320 26B0 81 08    CMP A  $08
00330 26B2 27 2D    BEQ    BACKSPC
00340 26B4 81 09    CMP A  $09
00350 26B6 27 15    BEQ    FORWARD
00360 26B8 81 04    CMP A  $04
00370 26BA 27 34    BEQ    DELETE
00380 26BC 81 01    CMP A  $01
00390 26BE 27 5D    BEQ    ADD
00400 26C0 81 12    CMP A  $12
00410 26C2 26 03    BNE    CONT3
00420 26C4 7E 273B  JMP    RECALL
00430 26C7 81 1F    CMP A  $1F
00440 26C9 2B DB    BMI    INPUT
00450 26CB A7 00    STORCH STA A  ,X
00460 26CD A6 00    FORWARD LDA A  ,X
00470 26CF 26 07    BNE    CONT2
00480 26D1 86 08    LDA A  $08
00490 26D3 BD 03F1  JSR    OUTC
00500 26D6 20 CE    BRA    INPUT
00510 26D8 08      CONT2 INX
00520 26D9 8C 00F8  CPX    $00F8
00530 26DC 26 C8    BNE    INPUT
00540 26DE 7E 04F0  ERROR JMP    BERROR
00550 26E1 8C 00B0  BACKSP CPX    $00B0
00560 26E4 27 03    BEQ    ATBEG
00570 26E6 09      DEX
00580 26E7 20 BD    LOOPBA BRA    INPUT
00590 26E9 86 09    ATBEG LDA A  $09
00600 26EB BD 03F1  JSR    OUTC
00610 26EE 20 B6    BRA    INPUT
00620 26F0 BD 0547  DELETE JSR    PSHX
00630 26F3 7F 004A  CLR    $004A
00640 26F6 A6 01    MOVELF LDA A  1,X
00650 26F8 BD 03F1  JSR    OUTC
00660 26FB A7 00    STA A  X

```

that it inserts a space at the cursor position and then shifts all characters from the cursor position one character to the right.

The recall routine is called by a control-R and uses lines 880-1490 of the program. To recall the line from memory into the BASIC buffer, lines 890-980 locate the requested line in memory and store its position in MEMPNT. Lines 1010-1370 then transfer the characters from memory into the buffer.

In SWTP BASICs, each line is stored in memory as a two-byte BCD line number, a two-byte address which represents the encoded keyword (such as PRINT, INPUT or IF), followed by the remaining characters of the line. Before the line can be physically transferred from memory back into the buffer, this two-byte code must be translated back into the keyword; this is done by subroutine STORKY, which locates the keyword in the BASIC jump table and stores it in the buffer.

When editing is completed, lines 1450 through 1500 position the index at the end of the buffer and jump to the BASIC reentry point to process the carriage return and place the line back into memory in its correct location.

The patch to the BASIC input routine that calls the editor when a control-E is first entered is shown at lines 1520-1640. This patch is the same for both BASIC versions 2.0 and 2.2. BASIC version 3.5, however, uses a different input routine as well as different entry points. Listing 2 shows how Ken Kroeker of Dakota Collegiate Institute, Winnipeg, Canada, modified the patch to work with this BASIC.

Finally, lines 1650 through 1670 change BASIC's end-of-program pointer to leave room for the editor patch, and also change the backspace and echo characters so that the standard backspace (control-H or ASCII \$08) is used instead of the standard control-O and underline echo.

TSC Text Editor Patch

The TSC Text Editor has a large variety of commands and operational modes, but it is line- rather than character-oriented. Moreover, it was originally intended for hard-copy as well as CRT terminal use. Thus, it is rather awkward to change characters in the middle of a line. The text editor patch described here can easily be implemented in the TSC editor to greatly

enhance its operation.

The original TSC Text Editor was cassette-based. It was later adapted, with relatively minor patches but without reassembly, to work on the SWTP disk system under MiniFlex, and on the Percom disk system under MINIDOS. Since all three versions resulted from the same assembly, Listing 4 applies to all of them except for the end-of-program pointers.

This affects the two ORG statements labelled as ***SEE TEXT*** in Listing 4. The addresses shown (\$1D7D and \$16DB) apply to Percom's "Touchup" version of the Editor.

In the original cassette version, the first ORG should read ORD \$1492. The last ORG, as well as the LDX #PRGEND following it, should be omitted.

In the MiniFlex version, the first ORG should read \$19DB, and the last ORG and the following LDX should also be omitted.

A/BASIC Modifications

Of all the 6800 higher-level language compilers, A/BASIC is the only one available in a cassette version. Since some recent statistics seem to indicate that there are more tape users than was thought, it's worth some space and time.

Though A/BASIC is relatively inexpensive (\$65 in the cassette version), it isn't nearly as popular as one would expect. There are several reasons.

First, Microware's ads state that the cassette version requires the RT/68 operating system. Though RT/68 is quite impressive as a multi-tasking, real-time execution program, it is not nearly as versatile as some other, more plain monitors. Nor is it compatible with any of them. (In fact, even if a program is compiled with unmodified A/BASIC on an RT/68 system, it will not run on computers with other monitors.) This, combined with its price of \$55, has not made it popular for the non-professional. (Microware, 5835 Grand Ave., Des Moines, IA 50304) has sold many more RT/68 manuals—to colleges and universities for text use—than ROMs.)

Second, the cassette version of A/BASIC is awkward to use. In fact, any compiler is awkward to use, but in a cassette form it is downright painful.

To run A/BASIC from cassette normally requires the following steps:

Listing 2 continued.

```

00670 26FD 08      INX
00680 26FE 7C 004A INC    $004A
00690 2701 4D      TST A
00700 2702 26 F2    BNE    MOVEFLT
00710 2704 86 20    SPACE LDA A    $520
00720 2706 BD 03F1 JSR    OUTC
00730 2709 7D 004A MOVECS TST    $4A
00740 270C 27 0A    BEQ    ENDD
00750 270E 86 08    LDA A    $508
00760 2710 BD 03F1 JSR    OUTC
00770 2713 7A 004A DEC    $4A
00780 2716 20 F1    BRA    MOVECSR
00790 2718 BD 055C ENDD JSR    PULX
00800 271B 20 CA    BRA    LOOPBACK
00810 271D BD 0547 ADD JSR    PSX
00820 2720 7F 004A CLR    $4A
00830 2723 C6 20    LDA B    $520
00840 2725 17      MOVRT TBA
00850 2726 E6 00    LDA B    X
00860 2728 A7 00    STA A    X
00870 272A BD 03F1 JSR    OUTC
00880 272D 8C 00FB CPX    $5FB
00890 2730 08      INX
00900 2731 27 AB    BEQ    ERROR
00910 2733 7C 004A INC    $4A
00920 2736 4D      TST A
00930 2737 26 EC    BNE    MOVRT
00940 2739 20 C9    BRA    SPACE
00950 273B 8D 5B    RECALL BSR    ZERCSR
00960 273D CE 00B0 LDX    $500B0
00970 2740 BD 0BA4 JSR    NUMC
00980 2743 24 03    BCC    CONT4
00990 2745 7E 0BA1 ERR2 JMP    BERR2
01000 2748 DF 24    CONT4 STX    $24
01010 274A BD 0B61 JSR    LINEC
01020 274D 25 F6    BCS    ERR2
01030 274F 08      INX
01040 2750 08      INX
01050 2751 DF 2C    STX    $2C
01060 2753 8D 1F    BSR    STORKYWD
01070 2755 08      INX
01080 2756 A6 00    SLOOP LDA A    X
01090 2758 4D      TST A
01100 2759 27 0A    BEQ    ENDR
01110 275B 81 19    CMP A    $519
01120 275D 2C 04    BGE    STRCHR
01130 275F 8D 13    BSR    STORKYWD
01140 2761 20 F3    BRA    SLOOP
01150 2763 8D 1C    STRCHR BSR    TRNSFR+2
01160 2765 DE 24    ENDR LDX    $24
01170 2767 A7 00    STA A    X
01180 2769 CE 00B0 LDX    $5B0
01190 276C BD 0520 JSR    PSTR
01200 276F DE 24    LDX    $24
01210 2771 7E 26A6 JMP    INPUT
01220 2774 EE 00    STORKY LDX    X
01230 2776 09      DEX
01240 2777 09      BACKUP DEX
01250 2778 A6 00    LDA A    X
01260 277A 26 FB    BNE    BACKUP
01270 277C 08      INX
01280 277D 08      INX
01290 277E 08      INX
01300 277F A6 00    TRNSFR LDA A    X
01310 2781 81 20    CMP A    $32
01320 2783 2D 0E    BLT    ENDSTR
01330 2785 08      INX
01340 2786 DF AC    STX    $AC
01350 2788 DE 24    LDX    $24
01360 278A A7 00    STA A    X
01370 278C 08      INX
01380 278D DF 24    STX    $24
01390 278F DE AC    LDX    $AC
01400 2791 20 EC    BRA    TRNSFR
01410 2793 DE 2C    ENDSTR LDX    $2C
01420 2795 08      INX
01430 2796 08      INX
01440 2797 39      RTS
01450 2798 8C 00B0 ZERCSR CPX    $5B0
01460 279B 27 08    BEQ    ENDZ
01470 279D 86 08    LDA A    $508
01480 279F BD 03F1 JSR    OUTC
01490 27A2 09      DEX
01500 27A3 20 F3    BRA    ZERCSR
01510 27A5 39      ENDZ RTS
01520 27A6 CE 00AF ENDRTN LDX    $5AF
01530 27A9 08      LOOP INX
01540 27AA A6 00    LDA A    X
01550 27AC 4D      TST A
01560 27AD 26 FA    BNE    LOOP
01570 27AF 7E 050C JMP    PLINEC
01580 27B2 81 05    PATCH3 CMP A    $5
01590 27B4 26 03    BNE    GOBACK
01600 27B6 7E 2698 JMP    EDIT
01610 27B9 B1 AC00 GOBACK CMP A    $AC00
01620 27BC 7E 04CA JMP    $4CA

```

More

Listing 2 continued.

```

01630      27BF      PRGEND EQU      *
01640 04C7      ORG      $4C7
01650 04C7 7E 27B2      JMP      PATCH3
01660 014E      ORG      $14E
01670 014E 27BF      FDB      PRGEND
01680 A048      ORG      $A048
01690 A048 0100      FDB      $100
01700      END
PSHX      0547
BERR0R    04F0
INPUTC    0428
OUTC      03F1
PULX      055C
BERR2     0BA1
NUMC      0BA4
LINEC     0B61
PSTR      0520
PLINEC    050C
EDIT      2698
CLEAR     269B
INPUT     26A6
CONT1     26B0
CONT3     26C7
STORCH    26CB
FORWAR    26CD
CONT2     26D8
ERROR     26DE
BACKSP    26E1
LOOPBA    26E7
ATBEG     26E9
DELETE    26F0
MOVELF    26F6
SPACE     2704
MOVECS    2709
ENDD      2718
ADD       271D
MOVERT    2725
RECALL    273B
ERR2      2745
CONT4     2748
SLOOP     2756
STRCHR    2763
ENDR      2765
STORKY    2774
BACKUP    2777
TRNSFR    277F
ENDSTR    2793
ZERCSR    2798
ENDZ      27A5
ENDRTN    27A6
LOOP      27A9
PATCH3   27B2
GOBACK    27B9
PRGEND    27BF

TOTAL ERRORS 00000

```

1. Load Microware's RTEDIT editor (supplied on the A/BASIC cassette) into the computer.

2. Run RTEDIT to enter and edit the source code.

3. When done, save the source code to cassette.

4. Load the A/BASIC compiler into memory.

5. Set up two cassette recorders—one to read the source code, the other to record the machine-language code. The recorder used to read the source code must have motor control so that A/BASIC can start and stop it as needed.

6. Start A/BASIC and start reading the source code.

7. A/BASIC is a two-pass compiler which must read the source code twice. After the first read is finished, rewind the tape.

8. Start both tape recorders and continue A/BASIC.

9. When the compiler is done, rewind both tapes and use the monitor's L function to read the machine language into the computer.

10. Now execute the program.

11. Since programs never run the first time, figure out what went wrong and go back to step 1 to start all over again, as many times as are needed to make it work.

Sound tedious? Right! Add to this the necessity to get RT/68, two tape recorders and motor control, and the process becomes expensive as well.

But there is a way out. With a little patching it is possible to use A/BASIC without spending as much time and without all the extra hardware. The patches do two things—allow RTEDIT and A/BASIC to work with MIKBUG or SWTBUG, and keep the source code in memory so it does not have to be read twice from tape by the compiler.

Listing 5 shows the patches required to RTEDIT. The first portion (down to location 01A6) substitutes the MIKBUG addresses for INEEE and OUTEEE instead of the addresses used by RT/68.

Immediately following is a short subroutine, at A04A, for printing a carriage return and line feed. RT/68 contains such a CR/LF subroutine, and Microware uses it both in the editor as well as in A/BASIC and even compiled programs. Thus, we need a short subroutine in RAM.

This first portion of the patch is all you need if you are using the SWTP AC-30 cassette interface with motor control and two recorders. However,

Listing 3. Editing modification for Percom Super BASIC.

```

      NAM      EDITOR      FOR SUPER BASIC
      *      R.SILVER MAY 13,1979
      * BASIC ENTRY POINTS
(08B5) PSX EQU $08B5      PUSH INDEX
(0081) BUFFER EQU $81      BEGINNING OF THE BASIC BUFFER
(00C9) BUFEND EQU $C9      END OF BUFFER
(10C7) BERR0R EQU $10C7      ERROR ROUTINE
(0570) INPUTC EQU $0570      INPUT ROUTINE
(0561) OUTC EQU $0561      OUTPUT ROUTINE
(08CA) PULX EQU $08CA      PULL INDEX
(002A) COUNTR EQU $2A
(004A) BUFNT EQU $4A      POINTER TO BUFFER POSITION
(002E) MEMPNT EQU $2E      POINTER TO MEMORY POSITION
(0047) TEMP EQU $47
(10C7) BERR2 EQU $10C7      ERROR ROUTINE
(1414) NUMC EQU $1414      NUMERIC CONVERSION
(0F22) LINEC EQU $0F22      FIND LINE IN MEMORY
(08A4) PSTR EQU $08A4      PRINT STRING ROUTINE
(0885) PLINEC EQU $0885      BRANCH POINT BACK TO BASIC
      * MISC CONSTANTS
(0008) BACK EQU $08      BACK SPACE CHARACTER
(0009) TAB EQU $09      FORWARD TAB CHARACTER
(3000) ORG $3000

```

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Listing 3 continued.

```

3000 BD 08B5 EDIT JSR PSHX
3003 6F 00 CLEAR CLR ,X CLEAR BUFFER TO END
3005 08 INX
3006 8C 00C9 CPX #BUFEND IS IT THE END OF THE BUFFER?
3009 26 F8 BNE CLEAR
300B BD 03CA JSR PULX
300E BD 0570 INPUT JSR INPUTC INPUT LOOP
3011 81 0D CMP A #$0D CHECK FOR CARRIAGE CONTROL
3013 26 03 BNE CONT1
3015 7E 310E JMP ENDRTN IF SO JUMP BACK TO BASIC
3018 81 08 CONT1 CMP A #BACK CHECK FOR BACKSPACE
301A 27 2D BEQ BACKSP
301C 81 09 CMP A #TAB
301E 27 15 BEQ FORWRD
3020 81 04 CMP A #$04 CONTROL D
3022 27 34 BEQ DELETE
3024 81 01 CMP A #$01 CONTROL A
3026 27 5D BEQ ADD
3028 81 12 CMP A #$12 CONTROL R
302A 26 03 BNE CONT3
302C 7E 30A3 JMP RECALL
302F 81 1F CONT3 CMP A #$1F CHECK IF CONTROL CHARACTER
3031 2B DB BMI INPUT IF SO IGNORE
3033 A7 00 STORCH STA ,X STORE CHARACTER IN BUFFER
* MOVE CURSOR FORWARD
3035 A6 00 FORWRD LDA A ,X
* CHECK IF AT END OF LINE IN BUFFER
3037 26 07 BNE CONT2 BRANCH IF NOT
3039 86 08 LDA A #BACK
* PUT CURSOR BACK WHERE IT BELONGS
303B BD 0561 JSR OUTC
303E 20 CE BRA INPUT
* MOVE TO NEXT POSITION IN BUFFER
3040 08 CONT2 INX MOVE TO NEXT POSITION IN BUFFER
3041 8C 00C9 CPX #BUFEND CHECK FOR END OF BUFFER
3044 26 C8 BNE INPUT
3046 7E 10C7 ERROR JMP BERROR
* BACKUP CURSOR
3049 8C 0081 BACKSP CPX #BUFFER CHECK IF AT START OF BUFFER
304C 27 03 BEQ ATBEG BRA IF SO
304E 09 DEX
304F 20 BD LOOPBA BRA INPUT
3051 86 09 ATBEG LDA A #TAB MOVE CURSOR FORWARD
3053 BD 0561 JSR OUTC
3056 20 B6 BRA INPUT

* DELETE A CHARACTER FROM BUFFER AND CRT
3058 BD 08B5 DELETE JSR PSHX
* ZERO COUNTER IN ORDER TO REPOSITION CURSOR
305B 7F 002A CLR COUNTR
* MOVE CURSOR AND BUFFER CONTENTS ONE POSITION LEFT
305E A6 01 MOVLFT LDA A 1,X
3060 BD 0561 JSR OUTC
3063 A7 00 STA A X
3065 08 INX
3066 7C 002A INC COUNTR COUNT CHARACTERS TO END
3069 4D TST A
306A 26 F2 BNE MOVLFT
306C 86 20 SPACE LDA A #$20 PRINT SPACE
306E BD 0561 JSR OUTC
* PUT CURSOR BACK TO CORRECT POSITION
3071 7D 002A MOVECS TST COUNTR CHECK TO SEE IF FINISHED
3074 27 0A BEQ ENDD
3076 86 08 LDA A #BACK
3078 BD 0561 JSR OUTC
307B 7A 002A DEC COUNTR
307E 20 F1 BRA MOVECS
3080 BD 08CA ENDD JSR PULX
3083 20 CA BRA LOOPBA

3085 BD 08B5 ADD JSR PSHX
* ADD SPACE TO BUFFER AT CURSOR POSITION
3088 7F 002A CLR COUNTR ZERO COUNTER

```

the rest of the patch will allow the source code to stay in memory while the compiler is loaded. (You'd still want to make a cassette tape of the edited source code now and then to guard against program loss, but this tape would be strictly for backup and not needed by the compiler.)

Listing 6 shows the patches required to the A/BASIC compiler itself. As before, the first part of Listing 6 must always be done to use A/BASIC with non-RT/68 systems. It patches A/BASIC to work with MIKBUG/SWTBUG-compatible monitors. Again, we see a CR/LF routine at A04A.

If you are not using two recorders and motor control, then the second half of the patch is required as well. This part allows A/BASIC to use the source code which was left in memory by RTEDIT. Note that A/BASIC needs to read the source code twice, but since the code is already in memory, that is easy to arrange without any extra work.

A/BASIC still needs a cassette recorder to store the machine-language object code, but this one need not have motor control. A/BASIC outputs the machine code fairly fast, but still slowly enough that the monitor will have no trouble reading it later. (It comes out in the standard SL....MIKBUG format.)

Once the machine-language code is on cassette, there is one more thing to do. A/BASIC does not insert CR/LF codes into the object code, but normally calls the appropriate routine in RT/68. The code output by the modified compiler will now call the routine at A04A instead. This means that this routine must be inserted into memory any time the object program is run.

If the program is to be run often, or if you intend to give a copy to someone else, it is much more convenient to append a short CR/LF routine to the end of the compiled program (the A/BASIC compiler tells you where the end is) and change all the references from A04A to the new address. Use a search program to find all occurrences of A04A in the object code and replace them with the address of the added subroutine.

A/BASIC Disk Operation

A/BASIC is, of course, most convenient to use in a disk system. Microware sells a disk version of A/BASIC for SWTP and SSB disk systems, but it costs \$150 rather than

More

\$65 for the cassette version.

If you don't need the disk files which the disk version allows, then you can patch the cassette version to work with a disk. A patch for the Percom disk system is part of the Percom Users' Library, and the patch for miniFlex is shown in Listing 7.

This program patches the cassette compiler to work with MIKBUG/SWTBUG systems, and to allow the use of miniFlex text files. The source code can be generated with either the BUILD command or, better yet, with the Text Editor.

Rather than write the compiled object code back on disk, this patch leaves it in memory starting at location \$2000 and returns to the monitor when done.

A/BASIC source code specifies by means of an ORG statement the location where the object code should go. Regardless of what origin is specified, this patch will place the object code starting at \$2000. If the code was originated at \$2000, then it is in the right place and can be executed immediately after compilation, or saved with the disk operating system's SAVE command for later use.

If the program was originated for a different location, then it must be moved there before it can be run. A memory move utility is part of the TSC Flex Utilities package, or else the MOVE routine (described in the September 1980 installment) can also be used.

Both the A/BASIC compiler as well as the compiled object program use Flex's PCRLF routine at \$711E for carriage returns and line feeds. If the compiled program is to be run on a non-miniFlex system, then it will again be necessary to insert a CR/LF routine somewhere, search out all the jumps to \$711E and substitute jumps to the new routine.

Listing 7 is set up for a 32K or larger system. If it is run on a smaller system, the instruction at 16BA will have to be changed to reflect the lower memory limit. It is presently set at \$6FFF so that the compiled program has 20K of room from \$2000 to \$6FFF, but does not erase miniFlex at \$7000.

One last thought—although it is tempting to try disassembling a compiler such as A/BASIC, and then reassembling on a 6809 system to produce a 6809 compiler, don't bother. Even if it runs, it will still generate 6800 code! Changing it enough to produce 6809 output is a tough job. ■

Listing 3 continued.

```

308B C6 20          LDA B #$20          PUT SPACE IN BUFFER
                   * MOVE CURSOR AND BUFFER RIGHT ONE PLACE
308D 17            MOVRT TBA
308E E6 00          LDA B X
3090 A7 00          STA A X
3092 BD 0561        JSR OUTC
3095 08             INX
3096 8C 00C9        CPX #BUFEND        CHECK FOR FILLED BUFFER
3099 27 AB          BEQ ERROR
309B 7C 002A        INC COUNTR        COUNT CHARACTERS FILLED
309E 4D             TST A
309F 26 EC          BNE MOVRT
30A1 20 C9          BRA SPACE
                   * RECALL LINE FROM MEMORY AND PLACE IN BUFFER
30A3 8D 5B          RECALL BSR ZERCSR  MOVE CURSOR TO START OF LINE
30A5 CE 0081        LDX #BUFFER      FIND LINE NUMBER IN BUFFER
30A8 BD 1414        JSR NUMC         CONVERT TO BCD FOR LINEC
30AB 24 03          BCC CONT4        INVALID LINE NUMBER?
30AD 7E 10C7        ERR2 JMP BERR2
                   * STORE POSITION OF END OF LINE NUMBER
30B0 DF 4A          CONT4 STX BUFPNT
30B2 BD 0F22        JSR LINEC        FIND LINE IN MEMORY
30B5 25 F6          BCS ERR2        BRANCH IF NOT FOUND
                   * SKIP PAST LINE NUMBER STORED IN MEMORY
30B7 08             INX
30B8 08             INX
                   * STORE POSITION OF LINE IN MEMORY
30B9 DF 2E          STX MEMPNT
30BB 8D 1F          BSR STORKY      STORE KEYWORD IN BUFFER
30BD 08             INX
                   * TRANSFER CHARACTERS FROM MEMORY TO BUFFER
30BE A6 00          SLOOP LDA A X
30C0 4D             TST A
                   * BRANCH IF LAST CHARACTER IN LINE
30C1 27 0A          BEQ ENDR
30C3 81 19          CMP A #$19      ANOTHER KEYWORD?
30C5 2C 04          BGE STRCHR      BRANCH IF NOT
30C7 8D 13          BSR STORKY      STORE KEYWORD IN BUFFER
30C9 20 F3          BRA SLOOP
30CB 8D 1C          STRCHR BSR TRNSFR+2 STORE CHARACTER IN BUFFER
30CD DE 4A          ENDR LDX BUFPNT  STORE $00 IN BUFFER
30CF A7 00          STA A X
30D1 CE 0081        LDX #BUFFER      PRINT CONTENTS OF THE BUFFER
30D4 BD 08A4        JSR PSTR
                   * SET INDEX TO LAST CHARACTER IN BUFFER
30D7 DE 4A          LDX BUFPNT
30D9 7E 300E        JMP INPUT
30DC EE 03          STORKY LDX 0,X    STORE KEYWORD IN BUFFER
30DE 09             DEX
30DF 09             BACKUP DEX        LOCATE KEYWORD IN TABLE
30E0 A6 00          LDA A X
30E2 26 FB          BNE BACKUP
                   * SKIP PAST JUMP ADDRESS IN TABLE
30E4 08             INX
30E5 08             INX
30E6 08             INX
30E7 A6 00          TRNSFR LDA A 0,X  TRANSFER CHARACTERS TO BUFFER
30E9 81 20          CMP A #32        LAST CHARACTER? OR KEY WORD?
30EB 2D 0E          BLT ENDSTR        BRANCH IF SO
30ED 08             INX
30EE DF 47          STX TEMP         STORE MEMORY POINTER
30F0 DE 4A          LDX BUFPNT        PICK UP BUFFER INDEX
30F2 A7 00          STA A X
30F4 08             INX
30F5 DF 4A          STX BUFPNT
30F7 DE 47          LDX TEMP
30F9 20 EC          BRA TRNSFR
                   * LOAD POSITION OF BUFFER AFTER LINE#
30FB DE 2E          ENDSTR LDX MEMPNT
                   * LOAD POSITION OF BUFFER AFTER LINE#
30FD 03             INX
30FE 08             INX
30FF 39             RTS
3100 8C 0081        ZERCSR CPX #BUFFER AT BEGINNING OF BUFFER?
3103 27 08          BEQ ENDZ        BRANCH IF YES
3105 86 08          LDA A #BACK
3107 BD 0561        JSR OUTC
310A 09             DEX

```

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Listing 3 continued.

```

310B 20 F3      BRA  ZERCSR
310D 39          ENDZ  RTS

310E CE 0080    ENDRTN LDX  #BUFFER-1 FIND END OF LINE IN BUFFER
3111 08          LOOP  INX
3112 A6 00      LDA  A X
3114 4D          TST  A
3115 26 FA      BNE  LOOP
3117 7E 0885    JMP  PLINEC
          (311A) PRGEND EQU  *

          (0847)      ORG  $0847
0847 81 05      CMP  A #5
0849 26 03      BNE  CONT6
084B 7E 3000    JMP  EDIT
084E B1 0153    CONT6 CMP  A $153      CHECK FOR CONTROL X
0851 27 D4      BEQ  $827
0853 B1 0154    CMP  A $154
0856 27 09      BEQ  CONT7
0858 81 0D      CMP  A #$0D      CHECK FOR CAR RETURN
085A 27 29      BEQ  PLINEC
085C 2D E3      BLT  $841
085E 20 0F      BRA  $86F
0860 01          NOP
0861 B6 0155    CONT7 LDA  A $0155
          (014E)      ORG  $14E
014E 31 1A      FDB  PRGEND

```

Listing 4. Editing modification for the TSC Text Editor.

```

          NAM  TSCEDIT  CURSOR EDIT FOR TSC EDITOR
          * R. SILVER APR 17,1979

(04BB)    BUFLIM EQU  $4BB
(0040)    TEMP  EQU  $40
(008E)    CHRCNT EQU  $8E
(0099)    FILEND EQU  $99
(0097)    FILBEG EQU  $97
(0091)    NUMBER EQU  $91
(0206)    INPUTC EQU  $206
(073B)    CLASS  EQU  $73B
(0209)    OUTC   EQU  $209
(038A)    TEDIT  EQU  $38A
(00BB)    BUFFER EQU  $BB
(045F)    BERR2  EQU  $45F
(0755)    NUMC   EQU  $755
(07AB)    LINEC  EQU  $7AB
(0485)    PSTR   EQU  $485
(03CC)    PLINEC EQU  $3CC

(1D7D)    ORG  $1D7D      *** SEE TEXT ***
1D7D BD 0206  PATCH  JSR  INPUTC
1D80 81 05    CMP  A #5      IS IT CONTROL E?
1D82 27 03    BEQ  EDIT
1D84 7E 049C  JMP  INCHR1
1D87 DF 40    EDIT  STX  TEMP
1D89 6F 00    CLEAR CLR  ,X
1D8B 08        INX
1D8C 8C 0143  CPX  #BUFFER+136
1D8F 26 F8    BNE  CLEAR
1D91 DE 40    LDX  TEMP
1D93 BD 0206  INPUT  JSR  INPUTC
1D96 81 0D    CMP  A #$0D
1D98 26 03    BNE  CONT1
1D9A 7E 1E77  JMP  ENDRTN
1D9D 81 08    CONT1 CMP  A #$08
1D9F 27 29    BEQ  BACKSP
1DA1 81 09    CMP  A #$09
1DA3 27 15    BEQ  FORWRD

```

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Listing 4 continued.

1DA5	81 04		CMP A	#\$04
1DA7	27 30		BEQ	DELETE
1DA9	81 01		CMP A	#\$01
1DAB	27 59		BEQ	ADD
1DAD	81 12		CMP A	#\$12
1DAF	26 03		BNE	CONT3
1DB1.	7E 1E23		JMP	RECALL
1DB4	81 1F	CONT3	CMP A	#\$1F
1DB6	2B DB		BMI	INPUT
1DB8	A7 00	STORCH	STA A	,X
1DBA	A6 00	FORWRD	LDA A	,X
1DBC	26 07		BNE	CONT2
1DBE	86 08		LDA A	#\$08
1DC0	BD 0209		JSR	OUTC
1DC3	20 CE		BRA	INPUT
1DC5	BD 04BB	CONT2	JSR	BUFLIM
1DC8	20 C9		BRA	INPUT
1DCA	8C 00BB	BACKSP	CPX	#BUFFER
1DCD	27 03		BEQ	ATBEG
1DCF	09		DEX	
1DD0	20 C1	LOOPBA	BRA	INPUT
1DD2	86 09	ATBEG	LDA A	#\$09
1DD4	BD 0209		JSR	OUTC
1DD7	20 BA		BRA	INPUT
1DD9	DF 40	DELETE	STX	TEMP
1DEB	7F 0091		CLR	NUMBER
1DDE	A6 01	MOVLFT	LDA A	1,X
1DE0	16		TAB	
1DE1	BD 0209		JSR	OUTC
1DE4	17		TBA	
1DE5	A7 00		STA A	X
1DE7	08		INX	
1DE8	7C 0091		INC	NUMBER
1DEB	4D		TST A	
1DEC	26 F0		BNE	MOVLFT
1DEE	86 20	SPACE	LDA A	#\$20
1DF0	BD 0209		JSR	OUTC
1DF3	7D 0091	MOVECS	TST	NUMBER
1DF6	27 0A		BEQ	ENDD
1DF8	86 08		LDA A	#\$08
1DFA	BD 0209		JSR	OUTC
1DFD	7A 0091		DEC	NUMBER
1E00	20 F1		BRA	MOVECS
1E02	DE 40	ENDD	LDX	TEMP
1E04	20 CA		BRA	LOOPBA
1E06	DF 40	ADD	STX	TEMP
1E08	7F 0091		CLR	NUMBER
1E0B	C6 20		LDA B	#\$20
1E05	17	MOVERT	TBA	
1E0E	E6 00		LDA B	X
1E10	A7 00		STA A	X
1E12	BD 0209		JSR	OUTC
1E15	BD 04BB		JSR	BUFLIM
1E18	7C 0091		INC	NUMBER
1E1B	17		TBA	
1E1C	26 F0		BNE	MOVERT+1
1E1E	20 D3		BRA	MOVECS
1E20	7E 045F	ERROR	JMP	BERR2
1E23	8D 44	RECALL	BSR	ZERCSR
1E25	CE 00BB		LDX	#BUFFER
1E28	BD 073B		JSR	CLASS
1E2B	C1 01		CMP B	#1
1E2D	26 F1		BNE	ERROR
1E2F	BD 0755		JSR	NUMC
1E32	86 3D		LDA A	#'=
1E34	A7 00		STA A	X
1E36	08		INX	
1E37	DF 40		STX	TEMP
1E39	BD 07AB		JSR	LINEC
1E3C	5D		TST B	
1E3D	26 E1		BNE	ERROR
1E3F	08		INX	
1E40	08		INX	
1E41	08		INX	
1E42	A6 00	SLOOP	LDA A	X
1E44	81 0D		CMP A	#\$0D
1E46	27 0E		BEO	ENDR

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Listing 4 continued.

```

1E48 08          INX
1E49 DF 91      STX  NUMBER
1E4B DE 40      LDX  TEMP
1E4D A7 00      STA A X
1E4F 08          INX
1E50 DF 40      STX  TEMP
1E52 DE 91      LDX  NUMBER
1E54 20 EC      BRA  SLOOP
1E56 DE 40      ENDR LDX  TEMP
1E58 86 04      LDA A #4
1E5A A7 00      STA A X
1E5C CE 00BB    LDX  #BUFFER
1E5F BD 0485    JSR  PSTR
1E62 DE 40      LDX  TEMP
1E64 6F 00      CLR  X
1E66 7E 1D93    LOOP2 JMP  INPUT
1E69 8C 00BB    ZERCSR CPX  #BUFFER
1E6C 27 08      BEQ  ENDZ
1E6E 86 08      LDA A #8
1E70 BD 0209    JSR  OUTC
1E73 09          DEX
1E74 20 F3      BRA  ZERCSR
1E76 39          ENDR RTS
1E77 CE 00BA    ENDRTN LDX #BUFFER-1
1E7A 5F          CLR  B
1E7B 08          LOOP INX
1E7C 5C          INC  B
1E7D A6 00      LDA A X
1E7F 4D          TST  A
1E80 26 F9      BNE  LOOP
1E82 D7 8E      STA B CHRCNT
1E84 86 0D      LDA A #SD
1E86 A7 00      STA A X
1E89 7E 03CC    JMP  PLINEC
1E8B 0D          FCB  $0D SET END
      (1E8C)      PRGEND EQU  *

      (0499)          ORG  $499
0499 7E 1D7D    INCHAR JMP  PATCH
049C 81 03      INCHRL CMP A #8

      (0358)          ORG  $358
0358 CE 1E8C    LDX  #PRGEND

      (16DB)          ORG  $16DB *** SEE TEXT ***
16DB CE 1E8C    LDX  #PRGEND
                        END

```

Listing 5. Patches required for RTEDIT to work with MIKBUG or SWTBUG.

```

* THIS PROGRAM PATCHES THE MICRO-WARE EDITOR
* TO WORK WITH MIKBUG/SWATBUG SYSTEMS
*
* MIKBUG EQUATES
E1AC          INEEE EQU  $E1AC
E1D1          OUTEEE EQU $E1D1
E0D0          MON   EQU  $E0D0
*
0D17          ORG   $0D17
0D17 E1 D1    FDB   OUTEEE
0D31          ORG   $0D31
0D31 E1 D1    FDB   OUTEEE
0DCF          ORG   $0DCF
0DCF E1 D1    FDB   OUTEEE
0D0E          ORG   $0D0E
0D0E E1 D1    FDB   OUTEEE
*
0D5D          ORG   $0D5D
0D5D A0 4A    FDB   CRLF
0DD6          ORG   $0DD6
0DD6 A0 4A    FDB   CRLF
*
0D23          ORG   $0D23

```

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PB1 Eprom Programmer.....	Kit	\$143	A&T	\$212
T1 Active Terminator.....	Kit	\$32	A&T	\$55
XB1 Extender Board.....	Kit	\$20	A&T	\$28

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Expandoram II 64k RAM Kit.....		\$216	A&T	\$395
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MPC-4 Multi Process.....	Kit	\$476	A&T	\$649

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 - Optional Printer
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Listing 5 continued.

```

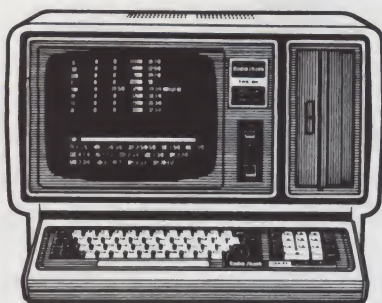
0D23 E1 AC          FDB  INEEE
0CF1                ORG  $0CF1
0CF1 E1 AC          FDB  INEEE
0CF1                ORG  $0CF1
0CF1 E1 AC          FDB  INEEE
*
01A6                ORG  $01A6
01A6 E0 D0          FDB  MON
*
A04A                ORG  $A04A
A04A 86 0A          CRLF LDA A  #$0A
A04C 8D 02          BSR  JOUT
A04E 86 0D          LDA A  #$0D
A050 7E E1 D1      JOUT  JMP  OUTEEE
*
* THE ABOVE IS ALL THAT IS NECESSARY IF YOU
* WANT TO USE THE AC-30.
* THE FOLLOWING WILL ALLOW THE SOURCE TO STAY IN
* MEMORY WHILE THE COMPILER IS BEING LOADED.
* THE COMPILER OUTPUT WILL STILL BE TO CASSETTE.
* NOTE SOME OF THE ABOVE PATCHES WILL NOT BE
* NECESSARY IF YOU DO THE FOLLOWING. ($0D0E, $0CF1,
* $0CF9) PATCH COMPILER TO USE MEMORY
*
*
*SECTION TO REWIND MEMORY
*
0100                ORG  $0100
0100 7E 20 23      JMP  REWIND
0103                RESTART EQU  $0103
* SECTION TO STORE SOURCE IN MEMORY
*
0DAB                ORG  $0DAB
0DAB 86 20          LDA A  #$20
0DAD 87 0D CF      STA A  JMEM+1
0DB0 86 10          LDA A  #$10
0DB2 87 0D D0      STA A  JMEM+2
0DB5 01            NOP
0DB6 01            NOP
0DB7 01            NOP
0DB8 01            NOP
0D39 86 02          LDA A  #$02      LOAD DATA START FLAG
0DBB 8D 11          BSR  JMEM
0DBD 8D D8          BSR  PBUFF
0DBF 86 03          LDA A  #$03      LOAD DATA END FLAG
0DC1 8D 08          BSR  JMEM
0DC3 86 E1          LDA A  #$E1
0DC5 87 0D CF      STA A  JMEM+1
0DC8 86 D1          LDA A  #$D1
0DCA 87 0D D0      STA A  JMEM+2
0DCD 39            RTS
0DCE 7E E1 D1      JMEM  JMP  OUTEEE
0D97                PBUFF EQU  $0D97
*
*
* SECTION TO LOAD MEMORY TO EDITOR
*
0CEA                ORG  $0CEA
0CEA 5F            CLR B
0CEB 8D 15          IN1  BSR  JIN
0CED 81 02          CMP A  #$02      START OF DATA
0CEF 26 FA          BNE  IN1
0CF1 8D 0F          IN2  BSR  JIN
0CF3 81 03          CMP A  #$03      END?
0CF5 27 08          BEQ  JEND
0CF7 A7 00          STA A  0,X
0CF9 08            INX
0CFA 5C            INC B
0CFB C1 80          CMP B  #$80      128 BYTES YET?
0CFD 25 F2          BCS  IN2
0CFF 6F 00          JEND  CLR  0,X
0D01 39            RTS
0D02 7E 20 00      JIN  JMP  DATAIN
*
*
2000                ORG  $2000

```

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- * Adds a new dimension and excitement to programming; lets you modify existing programs and games to add spoken announcements of results, warnings, etc.
- * Installs in just minutes.

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FIVE	THOUSAND	DRAIN	LOW	READY
SIX	MILLION	EQUAL	LOWER	RIGHT
SEVEN	ZERO	ERROR	MARK	SS
EIGHT	ALAN	FEET	METER	SECOND
NINE	AMPERE	FLOW	MILE	SET
TEN	AND	PIEL	MILL	SINCE
ELEVEN	AT	GALLON	MINUS	SPEED
TWELVE	CANDID	GO	MINUTE	STAR
THIRTEEN	CASE	GRAM	NEAR	START
FOURTEEN	UNIT	GREAT	NUMBER	STOP
FIFTEEN	AMPERE/TONE	GREATER	OF	THAN
SIXTEEN	HERTZ/TONE	HAVE	OFF	THE
SEVENTEEN	SILENCE	HE	IN	TIME
EIGHTEEN	SILENCE	HIGHER	OUT	TRY
NINETEEN	SILENCE	FOR	OVER	UP
TWENTY	SILENCE	PARANTHESIS	VOLET	
THIRTY	SILENCE	INCHES	PERCENT	WEIGHT
FOURTY	UNIT	IS	PLEASE	
FIFTY	CHECK	IT	PLUS	
SIXTY	COMMA	KILO	POINT	

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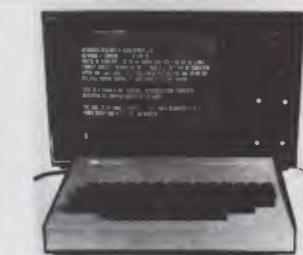
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• ASCII Character Set: 128 printable characters—

0123456789;(<=?
!@#\$%^&'()*+,-./:~
`abcdefghijklmnopqrstuvwxyz{|}~

BAUDOT Character Set: A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? * 3 5 8 () , . 9 0 1 4 1 5 7 : 2 / 6 8 *
Cursor Modes: Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing.
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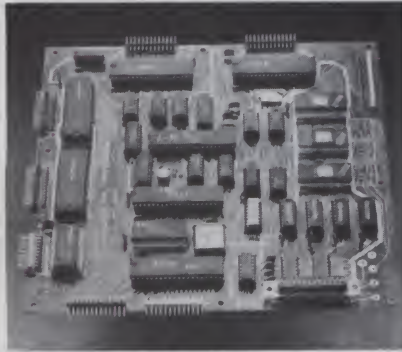
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With documentation.

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Listing 5 continued.

```

2000 FF 20 0D DATAIN STX XSAV+1
2003 CE 20 3B LDATA1 LDX #DATA
2006 A6 00 LDA A 0,X
2008 08 INX
2009 FF 20 04 STX LDATA1+1
200C CE 00 00 XSAV LDX #0000
200F 39 RTS

*
*
*
2010 FF 20 20 DATAOUT STX XSAV2+1
2013 CE 20 3B LDATA2 LDX #DATA
2016 A7 00 STA A 0,X
2018 08 INX
2019 FF 20 14 STX LDATA2+1
201C BD E1 01 JSR OUTEEE
201F CE 00 00 XSAV2 LDX #0000
2022 39 RTS

*
*
*
2023 4F REWIND CLR A
2024 C6 32 LDA B #32
2026 CE 20 3B LDX #DATA
2029 FF 20 04 STX LDATA1+1
202C FF 20 14 STX LDATA2+1
202F 7E 01 03 JMP RESTART

*
*
*
2032 RMB $9 ALTERNATE CRLF ROUTINE AREA

203B DATA EQU *
END

```

Listing 6. Patches required for A/BASIC to work with MIKBUG or SWATBUG.

```

* THIS PROGRAM PATCHES THE MICRO-WARE COMPILER
* TO WORK WITH MIKBUG/SWATBUG SYSTEMS
*
* MIKBUG EQUATES
E1AC INEEE EQU $E1AC
E1D1 OUTEEE EQU $E1D1
E0D0 MON EQU $E0D0
E0BF OUT2H EQU $E0BF
*
16E5 ORG $16E5
16E5 E1 AC FDB INEEE
18E5 ORG $18E5
18E5 E1 AC FDB INEEE
18ED ORG $18ED
18ED E1 AC FDB INEEE
1917 ORG $1917
1917 E1 AC FDB INEEE
*
16EE ORG $16EE
16EE A0 4A FDB CRLF
17D0 ORG $17D0
17D0 A0 4A FDB CRLF
1951 ORG $1951
1951 A0 4A FDB CRLF
*
16E2 ORG $16E2
16E2 E1 D1 FDB OUTEEE
17C9 ORG $17C9
17C9 E1 D1 FDB OUTEEE
1902 ORG $1902
1902 E1 D1 FDB OUTEEE
190B ORG $190B
190B E1 D1 FDB OUTEEE
1925 ORG $1925
1925 E1 D1 FDB OUTEEE
*
0827 ORG $0827

```

More →

Listing 6 continued.

```

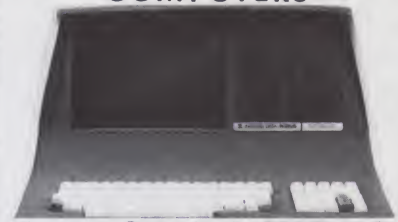
0827 E0 D0          *      FDB      MON
                                *
A04A                *      ORG      $A04A
A04A 86 0A          CRLF    LDA A   #$0A
A04C 8D 02          *      BSR      JOUT
A04E 86 0D          *      LDA A   #$0D
A050 7E E1 D1      JOUT     JMP      OUTEEE
                                *
                                * THIS WAS A TOUGH ONE
                                *
16D1                *      ORG      $16D1
16D1 BD A0 4A          *      JSR      CRLF
16D4 96 42          *      LDA A   $42
16D6 26 2C          *      BNE      CONT
16D8 39              *      RTS
16D9 EB 00          PATCH   ADD B   0,X
16DB 7E E0 BF          *      JMP      OUT2H
16DE 7E 16 D9          *      JMP      PATCH
1704                *      CONT     EQU      $1704
                                *
                                * THIS WAS EVEN TOUGHER
                                * FIXES OPT S
                                *
OF11                *      ORG      $OF11
OF11 01              *      NOP
OF12 01              *      NOP
                                *
                                *
                                * THE ABOVE IS ALL THAT IS NECESSARY IF YOU
                                * WANT TO USE THE AC-30
                                * THE FOLLOWING WILL ALLOW THE SOURCE TO STAY IN
                                * MEMORY WHILE THE COMPILER IS BEING LOADED
                                * THE COMPILER OUTPUT WILL STILL BE TO CASSETTE.
                                * NOTE SOME OF THE ABOVE PATCHES WILL NOT BE
                                * NECESSARY IF YOU DO THE FOLLOWING. ($18E5, $18ED)
                                * THE EDITOR WILL HAVE TO BE PATCHED TO MATCH
                                *
                                *SECTION TO REWIND MEMORY
                                *
00FB                *      ORG      $00FB
00FB BD 20 0D      BACK    JSR      REWIND
00FE 20 10          *      BRA      FWD
0100 20 F9          *      BRA      BACK
0110                *      FWD     EQU      $0110
                                *
                                *
                                *
                                * SECTION TO LOAD MEMORY TO COMPILER
                                *
18DE                *      ORG      $18DE
18DE 5F              *      CLR B
18DF 8D 15          IN1     BSR      JIN
18E1 81 02          *      CMP A   #$02      START OF DATA
18E3 26 FA          *      BNE      IN1
18E5 8D 0F          IN2     BSR      JIN
18E7 81 03          *      CMP A   #$03      END?
18E9 27 08          *      BEQ      JEND
18EB A7 00          *      STA A   0,X
18ED 08              *      INX
18EE 5C              *      INC B
18EF C1 80          *      CMP B   #$80      128 BYTES YET?
18F1 25 F2          *      BCS      IN2
18F3 6F 00          JEND     CLR      0,X
18F5 39              *      RTS
18F6 7E 20 00      JIN      JMP      DATAIN
                                *
                                *
                                *
2003                *      ORG      $2000
2003 FF 20 16      DATAIN STX      XSAV+1
2003 CE 20 3B      LOAD     LDX      #DATA
2006 A6 00          *      LDA A   0,X
2008 08              *      INX
2009 31 1A          *      CMP A   #$1A      END?
200B 26 05          *      BNE      STORE
200D CE 20 3B      REWIND   LDX      #DATA
2010 86 03          *      LDA A   #$03
2012 FF 20 04      STORE    STX      LOAD+1

```

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703-9 180 cps \$1569
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NEC SPINWRITER 5515 \$2395
Diablo 630 List \$2711 \$2399
Intertube III List \$895 \$729
Zenith Z-19 \$719
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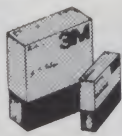
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8-channel differential — 16-channel — analog to digital
high accuracy — programmable gain instrumentation
amplifier — custom board test — \$100 — 2 to 15 kHz
conversion time — 1024 — 12-bit — sample and hold amplifier — gain
from 1 to 1024 — 16-channel — analog to digital
high accuracy — programmable gain instrumentation
amplifier — custom board test — \$100 — 2 to 15 kHz

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Listing 6 continued.

```
2015 CE 00 00 XSAV LDX #0000
2018 39          RTS
203B          DATA EQU $203B
```

*

* IT WILL BE NECESSARY TO KEEP THE CRLF IN
* \$A04A ANYTIME YOU ARE RUNNING PROGRAMS THAT
* HAVE BEEN COMPILED BY THE A/BASIC COMPILER
* A BETTER METHOD IS TO INSERT THE CRLF ROUTINE
* AT THE END OF THE COMPILED CODE. THE COMPILER
* TELLS YOU WHERE THE END IS. THEN SEARCH OUT
* THE JUMPS TO \$A04A AND PATCH TO THE NEW CRLF
* ROUTINE. (FOR AN EXCELLENT SEARCH ROUTINE SEE
* MAR 1978 73 MAGAZINE)

END

Listing 7. Program to use miniFlex text files.

*

* THIS PROGRAM PATCHES THE MICRO-WARE COMPILER
* TO WORK WITH MIKBUG/SWATBUG SYSTEMS
* AND TO ALLOW THE USE OF FLEX TEXT FILES.
* THE TSC EDITOR CAN GENERATE THE FILES.
* OUTPUT WILL BE TO MEMORY STARTING AT \$2000.
* PROGRAMS WITH ORG=\$2000 CAN BE RUN THERE, ELSE
* RELOCATE THEM TO ACTUAL ORG ADDRESS.
* MAKE THE FOLLOWING CHANGES TO THE
* PROGRAM TO THE ABASIC ORIGINAL (CASSETTE VERSION).
* MAKE ABASIC A COMMAND THEN USE ABASIC,<TEXT FILE>
* THE CRLF IS ROUTED TO FLEX. TO ALLOW THE
* COMPILED PROGRAMS TO RUN INDEPENDANT OF FLEX
* IT WILL BE NECESSARY TO SEARCH OUT THE JUMPS
* TO PCRLF AND PUT A CRLF ROUTINE AT THE END OF
* THE COMPILED PROGRAM.

*

*

*

* MIKBUG EQUATES

```
EO00 MON EQU $EO00
E1AC INEE EQU $E1AC
E1D1 OUTEE EQU $E1D1
E07E PDATA1 EQU $E07E
```

*

* FIX MON JUMP FOR COMPILED PROGRAMS

*

```
0A1A          ORG $0A1A
0A1A 86 E0    LDA A #$E0
0A1C C6 D0    LDA B #$D0
```

*

* FLEX EQUATES

*

```
7112 PUTCHR EQU $7112
710F GETCHR EQU $710F
7118 PSTNRG EQU $7118
7139 OUTHEX EQU $7139
711E PCRLF EQU $711E
7103 WARMS EQU $7103
7127 GETFIL EQU $7127
712D SETEXT EQU $712D
713C RPTERR EQU $713C
7806 FMS EQU $7806
7803 FMSCLS EQU $7803
7740 FCB EQU $7740
```

*

```
0100 ABASIC EQU $0100
```

*

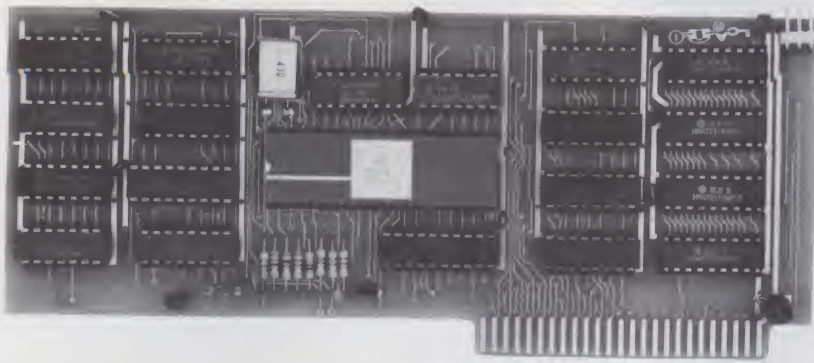
```
1917          ORG $1917
1917 E1 AC    FDB INEE
```

*

```
0103          ORG $0103
0103 76 1F    FDB REWIND
```

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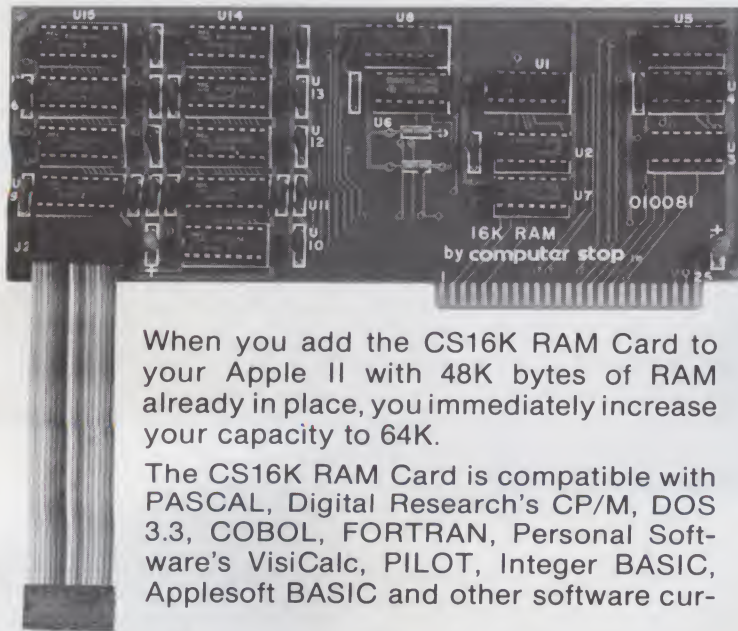
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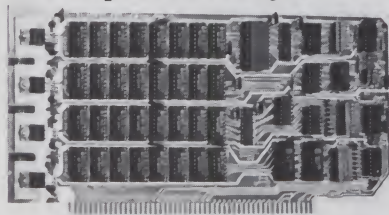
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Listing 7 continued.

17D0		ORG	\$17D0
17D0 71 1E		FDB	PCRLF
1951		ORG	\$1951
1951 71 1E		FDB	PCRLF
16E1		ORG	\$16E1
16E1 7E 71 12		JMP	PUTCHR
16E4 7E 71 0F		JMP	GETCHR
16E7 7E 17 0F		JMP	OUT4HS
16EA 7E 17 13		JMP	OUT2HS
16ED 7E 71 1E		JMP	PCRLF
16F0 7E 71 18		JMP	PSTRNG
170F		ORG	\$170F
170F BD 71 39	OUT4HS	JSR	OUTHEX
1712 08		INX	
1713 BD 71 39	OUT2HS	JSR	OUTHEX
1716 20 42		BRA	OUTSP
175A		ORG	\$175A
175A 86 20	OUTSP	LDA A	#\$20
175C 08		INX	
175D 7E 71 12		JMP	PUTCHR
17C9		ORG	\$17C9
17C9 E1 D1		FDB	OUTEEE
1902		ORG	\$1902
1902 E1 D1		FDB	OUTEEE
190B		ORG	\$190B
190B E1 D1		FDB	OUTEEE
1925		ORG	\$1925
1925 E1 D1		FDB	OUTEEE
0827		ORG	\$0827
0827 E0 D0		FDB	MON
* GO CLOSE ALL FLEX FILES			
1689		ORG	\$1689
1689 BD 76 2C		JSR	CLOSE
168C 01		NOP	
168D 01		NOP	
168E 01		NOP	
16A7		ORG	\$16A7
16A7 CE 00 90		LDX	#\$0090
16AA E6 00		LDA B	0,X
16AC 08		INX	
16AD 08		INX	
16AE 08		INX	
16AF A6 00	OUT1	LDA A	0,X
16B1 FF 16 C3		STX	OUT3+1
16B4 CE 20 00	OUT2	LDX	#\$2000
16B7 A7 00		STA A	0,X
16B9 08		INX	
16BA 8C 6F FF		CPX	#\$6FFF
16BD 27 0B		BEQ	OUT4
16BF FF 16 B5		STX	OUT2+1
16C2 CE 00 00	OUT3	LDX	#\$0000
16C5 08		INX	
16C6 5A		DEC B	
16C7 26 E6		BNE	OUT1
16C9 39		RTS	
16CA CE 16 D6	OUT4	LDX	#\$MSG1
16CD BD E0 7E		JSR	PDATA1
16D0 BD 76 2C		JSR	CLOSE
16D3 7E 71 03		JMP	WARMS
16D6 54	MSG1	FCC	/TOO BIG/
16DD 04		FCB	4

* CARRIAGE RETURN LINE FEED ROUTINE
* LOAD OUTPUT TO MEMORY STARTING AT \$2000

ORG	\$16A7	
LDX	#\$0090	GET BUFFER ADDRESS
LDA B	0,X	GET LENGTH
INX		SKIP TO DATA
INX		
INX		
LDA A	0,X	GET DATA BYTE
STX	OUT3+1	STORE POINTER
LDX	#\$2000	GET MEMORY ADDRESS
STA A	0,X	STORE DATA
INX		
CPX	#\$6FFF	ANY MEMORY LEFT?
BEQ	OUT4	NO-REPORT MEMORY FULL
STX	OUT2+1	YES-STORE MEMORY POINTER
LDX	#\$0000	RESTORE BUFFER POINTER
INX		
DEC B		
BNE	OUT1	ALL DONE, NO-GOBACK
RTS		
LDX	#\$MSG1	
JSR	PDATA1	
JSR	CLOSE	
JMP	WARMS	
FCC	/TOO BIG/	
FCB	4	


More


```

*
* THIS WAS TOUGH
* FIXES OPT S
*
0F11                ORG      $0F11
0F11 01             NOP
0F12 01             NOP
*
*
* SECTION TO LOAD FLEX TEXT FILE TO COMPILER
*
18DE                ORG      $18DE
18DE 5F             CLR B
18DF FF 18 F6 IN2   STX      XSAV+1    CLEAR B FOR BYTE COUNT
18E2 CE 77 40       LDX      #FCB      SAVE BUFFER POINTER
18E5 BD 78 06       JSR      FMS      POINT TO FCB
18E8 27 03          BEQ      XSAV      NO ERROR
18EA A6 01          LDA A 1,X         GET ERROR
18EC 31 08          CMP A # $08       END OF FILE?
18EE 27 03          BEQ      JRET2
18FO 7E 76 39       JMP      ERROR
*
18F3 86 03          JRET2  LDA A # $3
18F5 CE 00 00       XSAV  LDX      #0000    RESTORE X
18F8 A7 00          STA A 0,X
18FA 81 03          CMP A # $03       END?
18FC 27 06          BEQ      JEND
18FE 08             INX
18FF 5C             INC B
1900 C1 80          CMP B # $80       128 BYTES YET?
1902 25 DB          BCS      IN2
1904 6F 00          JEND  CLR      0,X
1906 39             RTS
*
* OPEN TEXT FILE FOR ABASIC
*
*
* REWIND FILE
*
761F 86 05          REWIND LDA A # $5    REWIND CODE
7621 CE 77 40       LDX      #FCB
7624 A7 00          STA A 0,X
7626 BD 78 06       JSR      FMS
7629 26 0E          BNE      ERROR
762B 39             RTS
*
* ERROR SECTION
*
7600                ORG      $7600
7600 CE 77 40       START LDX      #FCB    POINT TO FCB
7603 BD 71 27       JSR      GETFIL      GET FILE SPEC
7606 25 31          BCS      ERROR      ANY ERRORS
7608 CE 77 40       LDX      #FCB
760B 86 01          LDA A #1           SET DEFAULT EXT.
760D BD 71 20       JSR      SETEXT
7610 CE 77 40       LDX      #FCB
7613 86 01          LDA A #1           OPEN FOR READ
7615 A7 00          STA A 0,X
7617 BD 78 06       JSR      FMS
761A 26 1D          BNE      ERROR
761C 7E 01 00       JMP      ABASIC
*
762C 86 04          CLOSE LDA A #4      CLOSE FILE CODE
762E CE 77 40       LDX      #FCB
7631 A7 00          STA A 0,X
7633 BD 78 06       JSR      FMS
7636 26 01          BNE      ERROR
7638 39             RTS
*
*
7639 BD 71 3C       ERROR JSR      RPTERR
763C BD 78 03       JSR      FMSCLS    CLOSE FILES
763F 7E 71 03       JMP      WARMS    GOTO FLEX
*
END      START

```

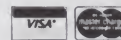
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Nature Red In Tooth and Claw

By Edward H. Carlson



With a snarl of hunger, the saber-toothed tiger leaped toward the...

Don't get too emotionally involved in this little drama of nature—after all, it's just a simulation. More about the sabertooths later. This article describes a two-level ecological niche in which a population of herbivores (browsers) feeds on foliage which grows back at a rate that depends on environmental factors.

The game resembles Conway's Life in several respects. It does its work out in the open, on a screen display that amuses the eye and prods the imagination. The two-level ecological system provides plenty of variety, from ecology in delicate balance to spectacular blooms of growth followed by sudden crashes from which there may, or may not, be recovery.

There are many adjustable parameters in the system, including rates of growth and nourishment, morphology of the leaves and mobility of the browsers. You can even add another trophic level if you wish: sabertooths pouncing on the browsers. In fact, so rich is the modeling of the system that even seemingly insignificant changes in the program can produce startling changes in the stability or rate of growth of the populations.

Any program that must continuously refresh a complicated screen display requires sophisticated programming if it is to run at a reasonable speed. I have found and will discuss some key techniques that reduce running time in BASIC programs to a minimum. At least they work for my machine's version of BASIC, and probably for most BASICs.

I have an Ohio Scientific C2-4P with 16K of programmable memory. It uses OSI Microsoft BASIC-in-ROM version 1.0, rev. 3.2. The screen has 2048 display cells, arranged in 32 rows of 64 characters each. The Browser Ecology program can easily be adapted to other screen sizes and to smaller-memory machines.

Browser's World is a Torus

The program listing is the simulation of the ecological system. The screen topology is the torus, or doughnut, often used in screen games; this is accomplished in lines 9, 42 and 83, which shift objects going off the bottom of the screen to the corresponding point at the top.

Due to the continuous nature of the screen memory array, objects shifted off the right edge of the screen appear at the left edge one line lower. Thus, the display is actually a spiral of 32 turns wound around the torus, much as a strip of tape could be spirally wound around an innertube, closing to a match at the ends. In such an arrangement, the cells at the four corners of the screen are actually adjacent to each other.

The Simulation

The simulation begins by randomly putting a number of browsers on the screen, each represented by the letter B, and a number of leaf cells, each represented by another character. (An X or an O would be appropriate, but I used character 187 from those available on the OSI graphics chip.) From that point on, browser-move-and-eat seasons alternate with leaf-growing seasons.

Information about browser J is stored in the element P of the array P(J). The integer part of P is the browser's position, and the decimal fraction part of P is the status of his energy reserve, E. The position of leaf cell J is stored in another array, PL(J).

The screen memory is an integral part of the program, not just a display array. Before a browser can be moved to a given cell on the screen, the cell is checked by a PEEK (line 10) to see if it is already occupied by a browser. If not, he is moved, and if the cell is part of a leaf, he is fed a unit F of nourishment (line 20). Likewise, a growing leaf can only expand into an empty cell on the screen.

In the browser-moving season, the list of browsers is scanned. As each entry is inspected, the browser is removed if dead. Otherwise, he is moved, then fed if he lands on a leaf and reproduced if his energy is over the reproduction threshold.

The list of browsers is kept compact by "garbage collection." Dead browsers in the middle of the list are replaced by live ones from the end. Newly born browsers are added at the end of the list. In each case, the number of browsers (NB) is updated. A flag (P = -1) is set at the end of the browser list, and, for speed in running, only that portion of the array P(J) containing live browsers is scanned each cycle.

During the leaf-growing season, the leaf list PL(J) is processed. I am treating these in a less dynamic way than the browsers. Growth is limited

Edward H. Carlson is a physics professor at Michigan State University, East Lansing, MI 48824.

to two possible directions and is independent of any individual cell food reserves. However, the growth rate is sensitive to overall crowding of the leaves (line 71).

Other schemes to treat leaves are possible, and you can easily modify the program to treat the leaves in a manner analogous to the browsers.

The dynamics of the simulation is largely determined by the browser energy E. As it is fed, its stored energy value rises toward a reproduction threshold, G (growth), at which it splits into two browsers. Each browser's energy is decreased by a factor Z at each cycle. If not augmented by feeding, the energy of a browser will decrease below the fatal threshold, D, after a number of seasons, and the browser dies.

Fast BASIC

I recently ran a number of timing tests on my machine and was surprised by the results. Several techniques for speeding up BASIC emerged. First, any number in a BASIC statement that is in digital form (rather than as a variable name) must be converted to floating point form every time it is encountered by the interpreter. This is a time-consuming operation, so variable names should be used instead of explicit constants.

Even the line number addresses in GOTO and GOSUB expressions must be decoded each time they are encountered, so there is an advantage to making them as short as possible. (This BASIC does not allow variables here.)

The line numbers at the beginning of each line are exempt from this discussion, as they are decoded once-for-all when the program is entered into source memory.

When GOTO or GOSUB is encountered, the interpreter must search for the line described, starting at the beginning of the program. The second surprise is that this requires a rather long time, 0.85 ms for each line examined. This time mounts up very rapidly, especially if the GOTO is called many times from an inner loop. Naturally, the closer the sought-for line is to the top of the program, the faster it is found.

These discoveries have changed my style of writing BASIC programs completely. I used to write a BASIC program in the same order as a FORTRAN program, with the introduction, initialization, explanation of variables and so on at the front, fol-

lowed by the main structure and with the subroutines collected at the end. Now, for BASIC programs, I reverse this completely, putting initialization at the end, main loops in the middle and subroutines and GOTO target lines first.

The style of the program after line 1000, where initialization starts, is quite different from the lines before 1000, where the main loop and subroutines are. Every effort is made to reduce the number of lines by putting multiple commands on a single line, using the colon separator. Sections whose lines are called from inner loops are put first, followed by those called less often.

Other, less important, time-saving techniques are also used. In an IF statement, make the branch most often taken the false one, if possible. In such cases, the part of the IF statement following THEN is not interpreted at all.

Variable names longer than two characters are redundant in this version of BASIC, so when variables are first introduced, they are presented as full descriptive words, such as SPACE, but truncated to the first two

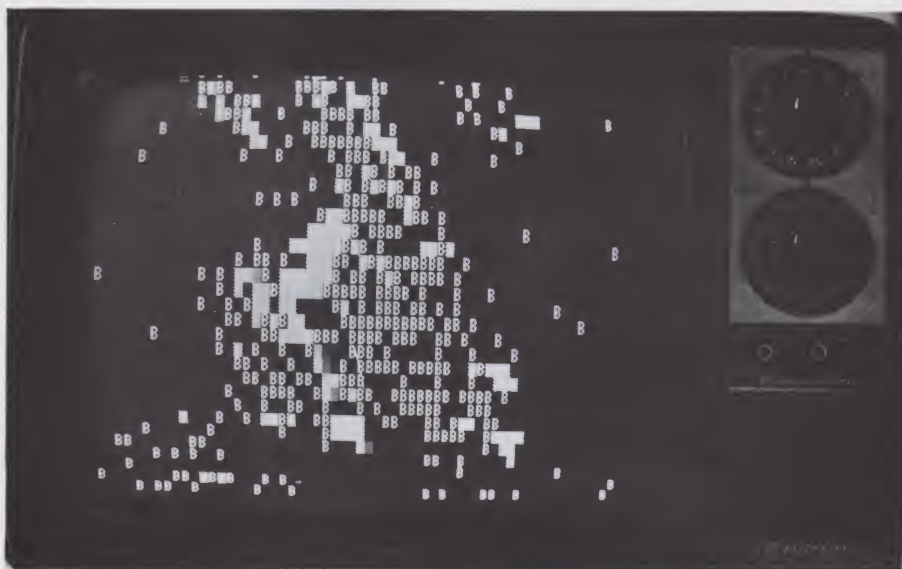
letters, SP, when used in time-sensitive parts of the code. Exceptions may have to be made. For example, LEAF, when truncated in an IF... THEN statement becomes ...LE THEN... , which is illegal, being interpreted as ...LET HEN....

A central feature of this program is the randomness of the browser movement and leaf growth. However, calling the random function, RND, is needlessly expensive (4.5 ms for each toss of the coin), so RND is called infrequently. Randomness is achieved mostly by using random initial conditions. Continuous shuffling of the lists P(J) and PL(J) by the garbage collection process maintains randomness as the program progresses.

There are a few tricks that are *not* worth using for speed-up purposes; these include leaving all spaces out of the lines and making all variables single letters. After all, clarity in reading the program is worth something, and the time saved would be small anyway.

Results and Variations

Now let's get down to cases. What



Browsers are represented by B, leaves by the filled-in areas. A cloud of browsers away from all leaves is a remnant population starving after having eaten all the food in their vicinity. The TV monitor is a Hitachi modified by a Pickles and Trout board.

Browser Ecology simulation program. Browsers feed on leaves. To minimize running time an inverted programming scheme is used: Subroutines are placed at the top, followed by the main loop, with initialization routines last.

```
1 REM ***** BROWSER ECOLOGY *****
2 REM
3 REM REMOVE ALL SELF STANDING REM LINES UP TO LINE 1000
4 REM
7 GOTO 1000
```

More →

happens when you run this simulation, and what can you find out by making various changes? When the program is run as is, it takes 18 seconds (on my machine) to complete the first "year" comprising a browser-moving season for 50 browsers and a growing season for 200 leaves.

After quite a few such years, a stable cyclic history is established. Picking up the cycle when the screen is nearly empty, you can see leaves start growing rapidly, diagonally down the screen, perhaps curling around the torus more than once. When the screen is almost full, the browser population explodes, eating greedily until the screen is nearly full of browsers and empty of leaves.

Most of the browsers then starve to death until the screen is nearly empty again, ready for the leaves to begin their period of rapid growth. The simulation can continue in this cyclic manner for many hours (real time).

Most of the changes you can make in the program fall into two broad classes—those affecting browser mobility and those affecting leaf shape (morphology). Although food ratio *F*, reproduction threshold *G*, death threshold *D* and metabolism *Z* are all separate and interesting parameters,

Listing continued.

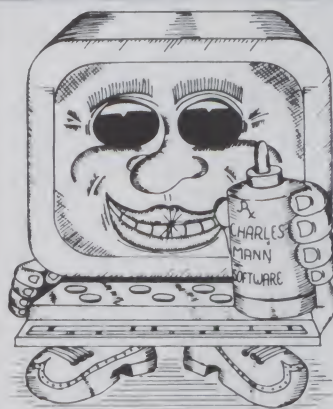
```

8 REM MOVE BROWSER
9 IF S<Q OR S>Q+SC THEN S=S+SC:IF S>Q+SC THEN S=S-2*SC
10 LK=PEEK(S):IF LK=B THEN S=S+D(ND):GOTO9
11 REM BROWSER FEEDS
12 IF LK=LEAF THEN E=E+F
13 REM BROWSER STARVES TO DEATH
14 IF E<D THEN P=P(NB):P(NB)=-1:NB=NB-1:R=INT(P):E=P-R:S=Q+R:RETURN
15 REM BROWSER SURVIVES
16 IF E<G THEN RETURN
17 REM BROWSER REPRODUCES
18 NB=NB+1:SN=S+D(ND)
19 IF SN<Q OR SN>Q+SC THEN SN=SN+SC:IF SN>Q+SC THEN SN=SN-2*SC
20 IF PEEK(SN)=B THEN SN=SN+D(ND):GOTO19
21 P(NB)=SN-Q+ES:E=ES:P(NB+1)=-1:RETURN
22 REM GROWING SEASON FOR THE LEAVES
23 J=INT(RND(8)*10)+1:JJ=NL:IF NL>.9*MAXL THEN GOSUB 98:RETURN
24 DJ=INT(2*MAXL/(MAXL-NL))
25 IF J>=JJ THEN NL=JJ:RETURN
26 PL=PL(J):IFPEEK(Q+PL)<>LEAF THENPL(J)=PL(J):JJ=JJ-1:J=J+DJ:GOTO27
27 PL=PL+1:IF PL>SC THEN PL=PL-SC
28 IFPEEK(Q+PL)<>SP THENPL=PL+1:IFPEEK(Q+PL)<>SP THENPL=PL+63:GOTO28
29 PL(JJ+1)=PL:JJ=JJ+1:POKE Q+PL,LEAF:J=J+DJ:GOTO 27
30 REM GARBAGE COLLECTION FOR LEAF ARRAY
31 JL=NL:FOR LL=1 TO NL
32 IF PEEK(PL(LL))<>LEAF THEN PL(LL)=PL(JL):JL=JL-1
33 IF LL=JL THEN LL=NL+1:NL=JL
34 NEXT:RETURN
35 REM ** MAIN LOOP **
36 FOR I=1 TO NL
37 P=I:IF P=-1 THEN 300
38 REM T IS THE OLD ADDRESS OF THE BROWSER, S THE NEW
39 R=INT(P):T=Q+R:E=(P-R)*Z:S=T+D(ND):ND=ND+1
40 IF ND>8 THEN ND=1
41 GOSUB 9:POKE T,SP:POKE S,B:P(I)=S+Q+E
42 NEXT
43 ND=INT(RND(8)*8)+1:GOSUB 70
44 GOTO 202
45 ***** BROWSER ECOLOGY *****
46 REM
47 1004 REM

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```

1006 REM          3872 RALEIGH DR.
1008 REM          OKEMOS MICHIGAN 48864
1010 REM
1011 Q=53248:SC=2047:REM Q IS UPPER LH CORNER OF SCREEN
1012 B=66:LEAF=187:SPACE=32:REM GRAPHICS CHARACTERS
1015 ES=.45:REM ENERGY AT THE START
1016 D=.3:REM DEATH THRESHOLD
1017 G=.5:REM REPRODUCTION THRESHOLD
1019 Z=.9:REM METABOLISM RATE
1021 F=.4:REM FOOD INCREMENT
1023 MAXB=700:REM NOTE: BOTH MAXB AND MAXL ARE STORED AS "MA"
1025 NB=50:REM NUMBER OF BROWSERS
1027 DIM P(MAXB):REM ARRAY HOLDS BROWSER POSITION AND ENERGY
1029 REM SET UP THE BROWSERS ON THE SCREEN
1030 FOR I=1 TO NB
1032 P=INT(RND(8)*((SC-128))+64
1034 IF PEEK(Q+P)<>SP THEN P=P+1:GOTO 1034
1035 IF P>2047 THEN P=P-64:GOTO 1034
1036 POKE Q+P,B
1037 P(I)=P+ES
1039 NEXT P(NB+1)=-1:REM FLAG FOR END OF BROWSER LIST
1040 MAXL=1200
1041 NL=200:REM NUMBER OF LEAVES
1042 DIM PL(MAXL)
1050 REM SET UP THE LEAVES
1052 FOR I=1 TO NL
1054 P=INT(RND(8)*((SC-128))+64
1056 IF PEEK(Q+P)<>SP THEN P=P+1:GOTO 1056
1058 POKE Q+P,L
1060 PL(I)=P
1070 NEXT
1099 REM: DIRECTIONS BROWSERS CAN MOVE
1100 DATA 1,-1,64,-64,63,-63,65,-65
1110 FOR I=1 TO 8
1120 READ D(I):NEXT
1121 D(0)=1
1990 ND=1
1994 REM: DJ USED TO SLOW LEAF GROWTH AT LARGE POPULATION
1995 DJ=10
2000 GOTO 202

```

collectively they determine how quickly the browsers can diffuse in a food-rich area, how explosively the population will grow and how rapidly it will crash after the food is gone.

Experimenting with these parameters is rewarding. In fact, it is easy to adjust them into a range where there is no recovery after the initial crash, or where there is exponential growth until the array size is exceeded.

The parameters F, G, D and ES are not completely independent; only the ratio of each of them to one given parameter, say F, is significant. (Be careful that G does not exceed 1, because E is taken to be the decimal fractional part of P.)

On the other hand, one can play with the initial numbers of browsers and leaf cells to search for stable populations in which oscillations do not occur.

Leaf morphology is important. Changing 63 to 62 in line 86 will yield vertical leaves. These act much like the diagonal leaves discussed above, but have a practical disadvantage if they grow into a ring around the torus. Then the growing season for leaves may become very long in real time because of a nearly infinite loop in lines 83 to 86.

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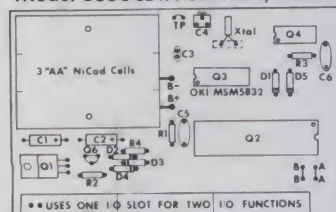
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Exploring other possible morphologies will yield different degrees of stability. The ability of roaming browsers to find newly-growing leaves, and of leaves to resist a bloom of browsers, depends greatly on leaf shape.

A larger change in the ecological behavior of the system results from a minor change in the code of line 44. Changing =B to <>SP means that when the browser bites into a leaf edge and then reproduces, the offspring may well appear on the other side of the leaf. This drastic increase in browser mobility will have to be offset by changes in one or more of the set F, G, Z or D.

The resulting stable ecosystem will have leaves that are nibbled to tatters before they get a chance to grow into nice, long leaves. Browser mobility between leaves can be increased by changing the step vectors in line 1100.

Leaf mobility can be introduced by adding a seed dispersal season after line 300, so that some number of single-cell baby leaves are scattered randomly over the screen. Likewise, dispersal of spores might be the proper behavior of browsers who have built up a large population facing dwindling food supplies.

Final Notes

You can follow the "years" better if you increment B after line 240. Then the successive symbols for the browsers become C, D, E and so on down to Z, whereupon you should use an IF to start the cycle over. The program will run OK, but a little illogically, because at any time during the browser-moving season there will be two kinds of browser symbols on the screen, but only one will be recognized by the rest of the program.

On the other hand, if you become really serious about this game, you will want to keep statistics on what is happening, either by storing an internal array, poking variable values onto the screen or outputting to a line printer. Here we part company, since I would rather just fool around with this game and, when the quiet munching of the browsers becomes too tame, open the door to the sabertooths! ■

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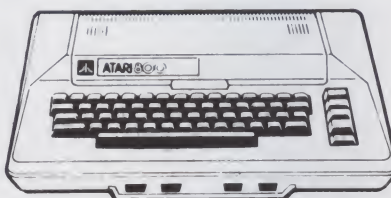
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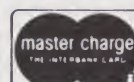
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The Data Grabber

By John Roos

Some of the most fascinating applications of small computers require sensing conditions external to the processor. Data collection, energy management, temperature measurement, industrial applications and home controls all demand that conditions external to the computer be converted to digital form. The numerical representation of the measured quantity is processed by the computer to achieve the desired control or measurement function.

Most low-cost sensors produce an analog output. This is in the form of a voltage, current or resistance change. An analog-to-digital converter converts the analog information (generally a voltage) to a digital word, which is input to the computer.

This eight-bit A/D conversion system, called Data Grabber, will interface to most computers via an eight-bit bidirectional parallel port. The Data Grabber is a complete A/D subsystem consisting of a 16-channel input multiplexer, step-gain amplifier, 3 μ s A/D and the necessary I/O and control functions to provide a highly versatile device.

Software control of the Data Grab-

ber is completely flexible; any input port can be selected in any order. In addition, the unit provides four input gain settings via a software-controllable step-gain amplifier. Either bipolar or single-ended input modes can be selected under software control.

Prior to discussing the design in detail, it is useful to review representative methods of analog-to-digital conversion.

A/D Conversion

Analog-to-digital conversion is done in a variety of ways. Most trade speed for accuracy or cost. A digital multimeter is a form of A/D converter in which speed is of no consequence as long as the user is not kept waiting more than a few tenths of a second. In computer-based applications, speed becomes important because the quantity being measured might vary rapidly, or because the processor should not be delayed by the A/D.

Most fast conversion schemes use a digital-to-analog converter in some form of feedback servo loop. Fig. 1a shows the basic idea. Here the digital

output of an up/down counter controls the D/A converter. The output from the D/A is compared with the analog input signal. The comparator output causes the counter to increment or decrement the digital input to the D/A. Counting continues until the output from the D/A equals the analog input. At this point the comparator causes the counter to stop until the analog input assumes a new value.

This scheme is called a "tracking" analog-to-digital converter. The analog output of the D/A follows the analog input to the comparator. The digital output is taken from the counter and always represents the present value of the analog input signal.

A tracking A/D has some disadvantages. It will follow a single input quite well, provided that the signal does not change value suddenly. If this occurs the counter must traverse many counts to reach the new level. During this period the digital output is incorrect. It is desirable to use a single A/D with a multiplexer so that many input sources can be processed. If these inputs are different in level, then the tracking A/D loses track and must slew to the new level presented by a different input signal when the multiplexer switches.

Consider the case of a ten-bit converter. There are 1024 possible counter states. If one input is at full scale and the next is at zero scale, all 1024 states must be traversed before the digital output correctly represents the new input level. Even if a 1 MHz clock is used, this process will still require 1.024 ms. Thus, the ma-

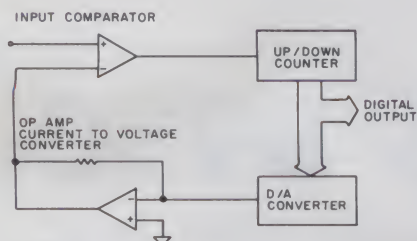


FIGURE 1A

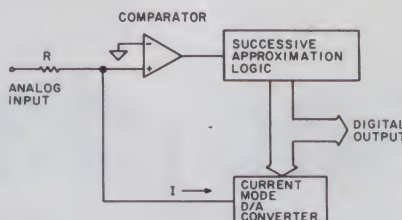


FIGURE 1B

Fig. 1. Two analog-to-digital conversion methods which use feedback from a digital-to-analog converter. The tracking converter (1A) utilizes an up/down counter to instruct the D to A to follow the analog input. A successive approximation approach (1B) is faster because fewer digital states are traversed in forcing the output of the D to A to equal the analog input.

John C. Roos (953 Valley High, Thousand Oaks, CA 91362) is an rf/microwave engineer.

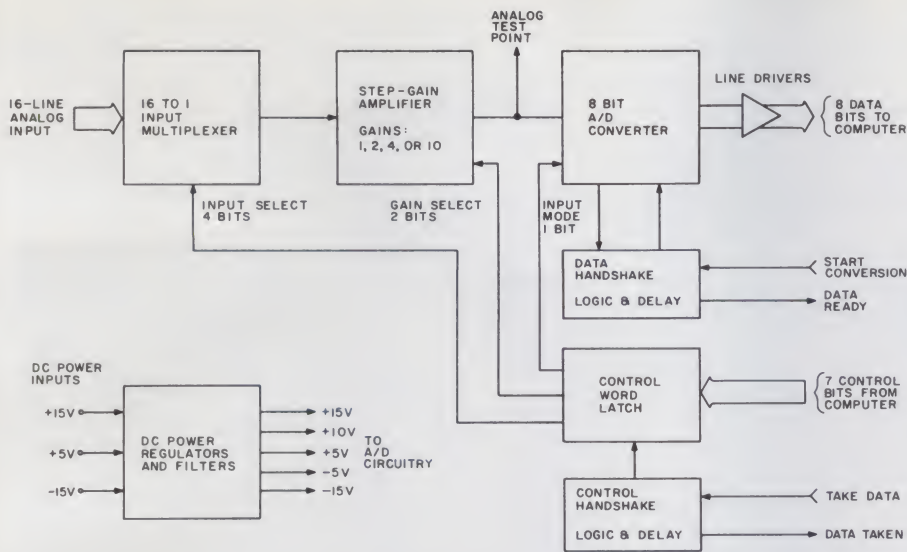


Fig. 2. Data Grabber block diagram. Input signal, amplifier gain and input mode are selected under software control.

jor disadvantage of the tracking A/D is that the conversion time is proportional to the change in input level.

Successive approximation is a technique that overcomes most shortcomings of the tracking A/D. This is a fancy name for trial and error. Fig. 1b shows the circuit arrangement. Like the tracking A/D, a feedback approach is used. A current output D/A is used in preference to a voltage output D/A. This eliminates an operational amplifier, which is often the slowest portion of the circuit.

As the analog input is increased, the circuit acts to sink more current in the D/A, and thus maintain the input voltage to the comparator at zero because of the drop in the input resistor. The comparator output controls the successive approximation logic, which in turn drives the D/A converter.

The trial-and-error conversion process proceeds as follows. First, the most significant bit (MSB) is set to a one, resulting in an output from the D/A of 50 percent of full scale. This is compared with the input. If the input still exceeds the D/A output, the MSB is retained in the one state and the next most significant bit is set to one. If the D/A output had been greater than the input, the MSB would be set to zero prior to setting the next most significant bit to one.

The process continues by again testing the output of the D/A relative to the input, and the state of the second bit is altered accordingly. The third most significant bit is then tested in the same way.

When all bits from MSB to LSB

have been tried, the conversion process is complete. It requires $N+1$ trials for a complete conversion for an N bit converter. A ten-bit successive approximation A/D requires 11 trials, as compared to 1024 steps for the tracking A/D approach. Thus, it is about 100 times faster. In the Data Grabber a successive approximation A/D converter is used. An eight-bit conversion requires only 2.8 μ s.

In selecting an A/D converter the accuracy and required resolution must be considered. They are not the same.

Accuracy refers to the absolute relationship between the digital representation of the input voltage and the true input voltage. On the other hand, resolution refers to the ability to resolve one input level from another. An A/D system can easily have a ten-bit resolution while achieving an accuracy of only 1 percent. Thus, you can see changes in voltage to a resolution of ten bits (0.1 percent), but the voltage is not known to an accuracy of more than 1 percent.

The accuracy will be less than the resolution unless the A/D converter and all analog components which precede it in the input signal path have the necessary precision. This is hard to do; an eight-bit converter requires that all analog errors be held to less than $1/256$ or less than 0.5 percent. Gain-setting resistors of such accuracy are both expensive and difficult to obtain. At ten bits and above, you must use extremely precise parts in the input circuitry. If accuracies of that order are required, then a complete commercial A/D subassembly is

probably the only way to go.

The application largely determines the required accuracy and resolution. Few sensors are accurate to more than eight bits (<0.5 percent) so for many measurements an eight-bit accuracy and resolution is more than sufficient.

You can use a 12-bit converter to accurately resolve and digitize to a resolution of one part in 4096. But unless you are exceedingly careful, the absolute accuracy will be much less, due to errors in the input circuitry.

Block Diagram

Fig. 2 is a block diagram of the Data Grabber. Analog data is applied to one of 16 signal input lines. A 16-to-1 multiplexer selects the desired signal for conversion. The selected signal is amplified by a step-gain amplifier and then routed to the A/D converter.

The step-gain amplifier permits matching of the input signal dynamic range to the A/D converter so that maximum resolution is maintained. Amplifier gains of 1, 2, 4 or 10 are selectable under software control. Thus, computer-controlled autoranging is possible if required.

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A Burr Brown-type ADC82 converter is used. This particular unit features a conversion time of less than 3 μ s and accommodates both bipolar and unipolar inputs. I used only the 0–10 and ± 5 V input ranges. Range extension is provided by the step-gain amplifier. A control line selects either the 0 to +10 V or the ± 5 V input ranges.

Data output is via a standard eight-bit parallel port with two handshake lines. One line starts the conversion process; the other signals the computer that valid data is ready. An optional 20 μ s delay is incorporated into the data handshake logic to permit transients on the data lines to settle prior to sending the data ready signal to the computer.

The parallel interface modules for my H-11 computer have a maximum communications rate of 50,000 words per second. Delaying the data ready signal by 20 μ s permits the interface to run at its maximum capability while permitting the cross-talk on the data lines to die out. I did this because my application requires a 30-foot cable between the computer and A/D unit. With this delay, com-

pletely error-free operation is obtained over long data lines.

Operation of the Data Grabber is software-controlled via an eight-bit control input port. Only seven bits are used. Control words from the computer are latched and applied to the multiplexer, step-gain amplifier and to the A/D input mode control.

Bits 0 through 3 control the input multiplexer, which selects one of 16 input lines. Bits 4 and 5 determine the gain of the step-gain amplifier. Setting both to zero results in unity gain. If bit 4 is one, then the gain is two and so on. Bit 6 selects the A/D input mode. If bit 6 is zero, the positive input (unipolar) mode is selected. Setting bit 6 to one permits positive and negative inputs (bipolar mode).

The combination of software-selectable input ranges and bipolar/unipolar input results in a very versatile A/D conversion system. Table 1 indicates the amplifier gain, input full-scale range and resolution in mV for the various combinations of bits 4, 5 and 6.

The unipolar mode has input full-scale ranges of 0–1, 0–2.5, 0–5 and 0–10 V. Resolution ranges from 3.9 mV

per bit to 39 mV per bit.

In the bipolar mode, input ranges of ± 0.5 , ± 1.25 , ± 2.5 and ± 5.0 V are obtained. Resolution also ranges from 3.9 to 39 mV per bit; 3.9 mV is a small signal and easily lost in amplifier offset and bias current effects. Considerable care was taken in the design of the step-gain amplifier to ensure that eight-bit accuracy as well as resolution was maintained on the most sensitive input ranges.

Power requirements for the Data Grabber are ± 15 V and +5 V. Internal regulation and filtering circuits produce +10 and –5 V, which are required by the input multiplexer and as a reference for some input sensors.

Schematic

Fig. 3 is the complete schematic diagram of the Data Grabber. Analog input signals may be applied to either front panel binding posts or to connectors on the rear panel. The two rear panel input connectors each accommodate eight analog inputs and their respective grounds. A +10 V reference is output from these connectors to bias external devices.

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Control Bit #			Amplifier Gain	Input Range	Resolution mV/LSB
6	5	4			
0	0	0	1	0-10	39.0
0	0	1	2	0-5	20.0
0	1	0	4	0-2.5	10.0
0	1	1	10	0-1.0	3.90
1	0	0	1	± 5.0	39.0
1	0	1	2	± 2.5	20.0
1	1	0	4	± 1.25	10.0
1	1	1	10	± 0.50	3.90

Table 1.

channels are available at the front panel, on the theory that any project requiring more than eight inputs is a major undertaking and the rear panel connectors would be preferred.

From the input connectors, the analog voltage is routed to the multiplexer via resistors R1 through R16. These resistors provide overvoltage protection and will limit the current through the input protection diodes within the multiplexers, IC1 and IC2.

The multiplexers are 4051 CMOS transmission gates. Each contains a single-pole, eight-position analog switch. The switches are controlled with a three-bit word which selects the input line. A fourth bit is used as a disable bit. If this bit is a one, no input can be enabled. The disable input is used to expand the multiplexer from eight to 16 input lines by switching one multiplexer off when the other is being used.

The input is selected by connecting the three control bits to both IC1 and IC2. Bit 4, the disable bit, is applied directly to IC1, pin 6. This signal is inverted by IC9D before being sent to the enable input of IC2. When this bit is zero, IC1 is enabled and the inputs from 0 to 7 are active. When bit 4 is set to one, then IC1 is off and IC2 is active. In this state the inputs from 8 to 15 are selected. Open collector buffers IC3 and IC9 interface the CMOS multiplexer to the TTL control latch, IC11.

Input signals applied to the 4051 multiplexers must not exceed the supply voltages. To accommodate the maximum input ranges of 0 to +10 and +5 to -5 V, the 4051 multiplexers are operated from +10 to -5.0 V supplies. The protection resistors limit current in the input diodes of IC1 and IC2. Damage will not occur for inputs of at least 25 V or more.

A higher resistance cannot be used because the step-gain amplifier input bias current passes through the mul-

tiplexer and the input protection resistors. The amplifier input impedance is several megohms, but the series resistance must be kept low to preclude input errors due to the bias-current-induced voltage drop in the resistor.

From the multiplexer, the input signal is sent to IC4, the step-gain amplifier. A Harris type HA-2405 programmable amplifier provides four gain settings. Internally, the 2405 consists of four differential input sections, a four-way multiplexer and an output stage. Two digital control lines permit selection of any input section. This versatile chip is a natural for programmable signal processing circuits. Four completely independent feedback networks may be used from the output to each input to provide a wide range of performance variation.

Four gain settings are used: 1, 2, 4 and 10. To obtain a gain of 1, the output, pin 10, is connected directly to pin 5, which is the inverting input of the first section. A gain of 2 is obtained from connection of the output to the inverting input of the second section, pin 7, via the feedback network R28, R29 and R30. R30 is the gain adjustment trimmer.

In similar fashion, the gain of 4 is set with the network R25, R26 and R27, and the gain of 10 is set by R22, R23 and R24. A trimmer is required in each feedback network to set the gain. One percent resistors are used but are of insufficient accuracy for an eight-bit converter. Remember, one LSB equals 1/255, which is a precision of better than 0.5 percent!

Pins 1, 3, 6 and 8 of the 2405 are the noninverting inputs. These are paralleled and connected to the multiplexer outputs.

On the highest gain ranges, the offset voltage of IC4 becomes significant, since one LSB is equivalent to only 3.9 mV. R45 is used in conjunction with R46 and R47 to null the off-

set of the two highest gain input amplifiers. I got away with a single control because the offsets for two sections of the same chip were about the same. Some 2405s may require a second control.

Capacitor C1 is required to stabilize the 2405 when set up for unity gain. With this value, 100 pF, the amplifier still has a unity gain bandwidth of 2 MHz.

A BNC connector, J3, is provided to connect the output of the step-gain amplifier to external test equipment. J3 is used for gain adjustment. It also may be used to view the analog signal on a scope to detect problems with noise or cross-talk.

From the step-gain amplifier the signal is routed to IC5, the ADC82 analog-to-digital converter. The A/D converter has a number of strapping options for selection of the input signal range. Full-scale ranges may be strapped for 0 to 5, 10 or 20 V in the unipolar mode, and for plus or minus 2.5, 5 or 10 V in the bipolar mode.

In my design, only the 0 to +10 and ± 5 V ranges are used because the more sensitive ranges require trimming to obtain one LSB accuracy. The step-gain amplifier is used to obtain more input sensitivity.

This arrangement has two hidden benefits. First the A/D converter has a very low input impedance, only 6.25k. An input buffer is required to raise the input impedance to avoid loading the source and also to preclude excessive voltage drop in the on-resistance of the analog multiplexer. A second benefit is versatility.

Obtaining Parts

Most parts required to construct your own Data Grabber can be purchased from the usual IC vendors. The A/D converter and DG303CJ can be obtained by writing the manufacturers directly and asking for the name of a local distributor. The maker will also sell directly provided you first obtain the total price in advance and then send a check. Here are the addresses:

●Burr Brown Research, International Airport Industrial Park, PO Box 11400, Tuscon, AZ 85734 (602-746-1111).

●Siliconix, 2201 Laurelwood Road, Santa Clara, CA 95054 (408-338-0227).

The step-gain amplifier is easily modified so that other full-scale input voltage ranges may be obtained. In the Data Grabber the most sensitive ranges are 0-1 and ± 0.5 V full-scale. More sensitivity is obtained by simply altering the feedback around IC4.

Normally, the A/D is set up for a 0 to +10 V input. Strapping pin 16 to pin 18 connects an internal offset current source to the comparator input for bipolar operation. This offsets the input range so that a -5 V input results in a zero scale digital output. An input of 0.0 V produces a midscale binary output, and +5.0 V produces a full-scale binary output.

The analog switch, IC14, permits selection of the bipolar input mode under software control. A Siliconix type DG 303 switch was used because a very low on-resistance is required. Both sections of the DG 303 are wired in parallel to lower the on-resistance. Each section has an on-resistance of less than 50 ohms. Low resistance is required since the internal offset current source in the A/D has a source impedance of 7.8k. To hold the offset error to less than one LSB, the switch resistance should not ex-

ceed 7.8k divided by 255, or about 30 ohms.

The ADC82 has its own internal clock, which is output on pin 1 and strapped to the clock input pin 22. Analog-to-digital conversion is initiated by a high-to-low transition on pin 23. When the conversion is complete, the status output, pin 3, goes low. The start line must be kept low until the conversion is completed. When the status line goes low, the clock is high for one-half clock cycle. A slightly delayed conversion complete signal is obtained by an AND of the clock and the status lines. These are LOW true signals so a 7402 NOR gate, IC6, is used to perform the negative AND.

The conversion complete signal appears at the output of IC6 and 700 ns after the data is valid at the A/D output. This signal actuates the data handshake circuitry, which consists of IC7 and IC10.

The eight-bit parallel output and handshake lines are designed to interface to a parallel interface module in my Heath H-11 computer. This approach is commonly used, and most computers offer a similar interface capability. The parallel handshake

lines are called SDL (send data LOW) and DSL (data sent LOW).

At the completion of a data transmission, SDL is HIGH and DSL is LOW. The computer requests data from the A/D by asserting SDL LOW. The A/D causes DSL to go high, which indicates to the computer that the external device is busy and that the data on the parallel lines is invalid.

For my computer to correctly interpret the busy signal, the DSL line must go high within about 200 ns of the occurrence of SDL. If this is done properly, the external device can take a week to respond. When the A/D has completed the conversion, DSL is set LOW and the computer takes the data. SDL remains high until the next request.

SDL is applied to the PRESET input of IC10, a type 7474 flip-flop. LOW on the PRESET sets the Q output HIGH and the QBAR output LOW. Q is sent to the buffer, IC3 section E, and returned to the computer as the DSL line, which assumes the HIGH, or busy, state. QBAR is sent to the A/D converter as the start conversion command. Analog-to-digital conver-

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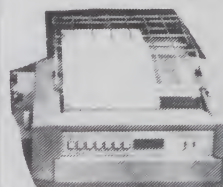


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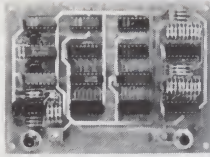
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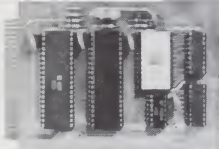


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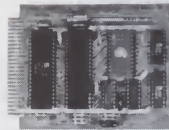
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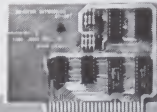


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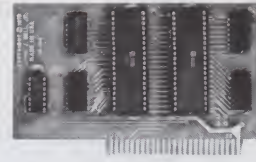
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Photo 1. The Data Grabber is housed in a small instrument case. Front panel connections include eight inputs, with ground returns, and eight reference voltage outputs. BNC connector, J3 at lower right, is the analog output test point. Seven LEDs indicate the command status. An eighth LED indicates power on.

sion is initiated. When the conversion is complete, valid data appears on the parallel output lines.

IC6 outputs a delayed (by about 700 ns) conversion complete signal to IC7, a 74121 monostable. IC7 is used to delay the sending of the DSL signal so that the transients on the data lines have time to die out. This is not strictly necessary, but it does reduce the errors on long lines. When IC7 times out, its QBAR output returns to the HIGH state and clocks IC10. The Q output of IC10 is clocked LOW and returns the DSL line to the LOW condition, which indicates to the computer that it should take the data.

Data from the A/D is output in a complementary binary format. 7406 inverting buffers, IC8 and IC9, invert the data and drive the output lines to the computer. After this inversion the data is in normal binary format; 00000000 is zero scale and 11111111 is full scale for the unipolar input ranges. The code is offset when the bipolar input mode is used. 00000000 is output for negative full-scale inputs; 11111111 is transmitted for positive full-scale inputs. An input of 0.0 V results in a midscale binary output, or 10000000.

The line drivers use 510 ohm pull-up resistors to reduce the effects of capacitive coupling between lines. Low impedance loads, combined with the intentional 20 μ s handshake delay, permit operation with at least a 30-foot cable between the A/D converter and the computer.

A similar eight-bit port permits the

computer to control the Data Grabber. Only the seven least significant bits are used. Two handshake lines, TDL (Take Data LOW) and DTL (Data Taken LOW), control the command word transmissions.

A command from the computer is sent to IC11, an 8212 eight-bit latch. Then the TDL line is asserted LOW by the computer parallel interface. IC12, a 74121 monostable, is set by this signal. The Q output of IC12 goes HIGH, which in turn causes the 8212 latch to become transparent to the input data. The QBAR output of the 74121 is inverted and returned to the parallel interface as the DTL signal. This line assumes the HIGH, or busy, condition.

IC12 then times out and returns pin 11 of the latch LOW. This latches the command word. At the same time QBAR of IC12 returns HIGH and the DTL line is returned LOW by the inverting output buffer IC9 section C. Assertion of DTL LOW informs the computer that the command word has been received by the Data Grabber.

From the command latch, the seven control bits are routed to the multiplexer, step-gain amplifier, input mode switch and LED display drivers.

Bits 0-3 select the input channel. They are routed to the input multiplexer via IC3 and IC9, which interface the TTL signals to the CMOS multiplexers.

Bits 4 and 5 control the step-gain amplifier. They connect directly to

input selector lines D0 and D1 of the 2405 step-gain amplifier.

The last control bit, bit 6, connects to the control port of the mode selection switch, IC14. Bit 7 is not used.

A front panel display indicates the current command status. Seven LEDs are used to indicate the state of each bit in the command word. This feature is useful when debugging the control software. By single-stepping the program through the programmed control sequence, proper operation can be verified. The LEDs are driven by 7406 inverting buffers, IC13 and one section of IC9.

Power for the Data Grabber is supplied from external ± 15 and +5 V supplies. Regulators IC15 and IC16 develop +10 and -5 V, which are used internally. The +10 V supply powers the input multiplexer and is also output as a precision reference.

A reference voltage is useful to bias sensors used with the A/D converter. Thermistors or other resistive devices require stable bias for operation. The +10 V supply is routed to the front panel binding posts and to the rear panel input connectors for this purpose.

A 78MG adjustable regulator is used for the +10 volt reference supply. While not as good as a super reference diode, its stability with temperature is adequate and the cost is much lower. Temperature stability of the reference supply should be much better than one LSB because drift in the reference will directly affect measurement accuracy. Of course, this is most critical on the more sensitive input ranges. Let's see how the reference compares to one LSB.

A temperature coefficient of 0.4 mV per degree Centigrade is specified for the 78MG regulator. Thus, its output can be expected to remain within ± 4 mV for a ten-degree increase or decrease in ambient temperature. One LSB equals 39 mV on the 0-10 V input range and 3.9 mV on the 0-1 V range. So under most conditions the reference will contribute less than one LSB error.

Precision resistors, R41 through R44, are used with trimmer, R40, to set the reference supply output. Use 1 percent metal film resistors if obtainable. R43 and R49 are included to prevent an overvoltage output from IC15 should the pot wiper go open. IC15 can supply over 500 mA. Overvoltage damage to the multiplexer could result in an excessive input to the step-gain amplifier chip. The

CMOS multiplexers are inexpensive, but the 2405 is not.

Construction

I constructed the Data Grabber on a 5×11 inch piece of one-sixteenth inch copper clad PC card. The card is housed in a 4.5×8×11 inch cabinet (Photo 1).

While the layout is not terribly critical, the circuit does handle signals as small as a few mV. Use of a ground-plane is mandatory to prevent pickup of hum and noise. One reason for not including a power supply in the same cabinet was to provide isolation from an obvious source of magnetic interference.

I arranged the circuit components on the board for maximum isolation of the analog and digital portions. The analog inputs are at the lower right of the circuit card (Photo 2). Sixteen input protection resistors are mounted on Teflon standoffs. Above these are the multiplexers, IC1 and IC2, and the 2405 step-gain amplifier, IC5. All of the gain setting and offset adjustments and their associated fixed resistors are at the extreme upper right of the card. Orientation of the trimmer controls to the right of the card permits adjustment by removal of the top of the chassis. It is not necessary to remove the card from the box.

The A/D converter is located at the left of the analog circuits. To its right is the input mode switch, IC14. At the left of the A/D are ICs 8, 9, 6, 7, 10

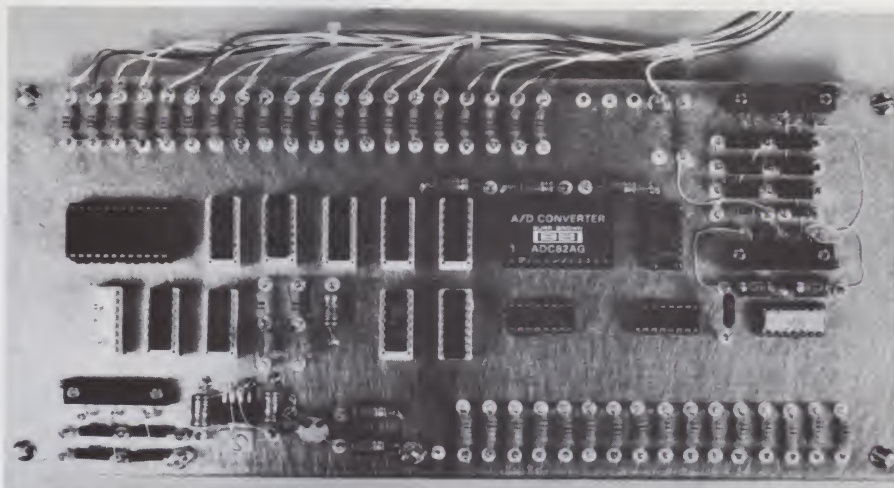


Photo 2. A single circuit card holds all components. Wire-wrap construction is used. A copper ground plane is required to prevent cross-talk and noise pickup.

and 11. Starting from the left of the card, the next row contains a 1k DIP resistor network, IC13, IC12, the timing components for the two one shots, IC3 and the 10k resistor network. This last item is adjacent to the input multiplexer IC2.

Both voltage regulators are at the lower-left edge of the card.

At the upper-left edge of the card are the 510-ohm pull-up resistors for the TTL I/O lines. Twenty resistors are used. DIP resistor networks could have been used, but in any event, a terminal is required to connect the 30-gauge wire-wrap wire under the card to the 22-gauge leads to the connectors. In addition, the terminal pro-

vides a ready-made test point, so use of discrete resistors is convenient.

All ICs are mounted in wire-wrap sockets, and wire-wrap interconnections are used except where a lead terminates at a Teflon feed-through. These connections are soldered.

On the front panel are located the input connections, reference output terminals, the analog output BNC connector and the LEDs for the status display. Rear panel connectors include the two analog input connectors, Digital I/O and a power connector. A set of binding posts, which duplicates the power input connections, is also provided.

Testing

Testing of the A/D converter should be done after assembly and wiring of the card and prior to installing it in the chassis.

Test the dc regulators and wiring first. Adjust the +10 V supply for an output of exactly 10.000 V. Do not install the A/D converter until you have verified that everything is OK. Check that not only the dc voltages supplied to the A/D are correct, but also that the digital outputs are not shorted.

Write a short program to drive the Data Grabber. This can be pretty simple. All it must do is send a control word to the unit and then continually interrogate the digital output. Listing 1 is the program I used with my H-11 computer. This program permits you to send a command where the number N is the decimal representation of the binary command word.

Remember, the binary command is divided into subsections. The first

```
100 REM THIS PROGRAM SENDS A SINGLE COMMAND TO THE A TO D
110 REM CONVERTER. THEN IT REPEATEDLY READS THE DIGITAL OUTPUT
120 REM USE TO TEST THE -DATA GRABBER-
200 PRINT "TYPE COMMAND NUMBER 0-127 ";
210 INPUT N
300 REM COMMAND IS FOKED TO A TO D VIA PARALLEL INTERFACE
310 REM 65388 IS ADDRESS OF TRANSMITTER STATUS REGISTER
320 REM 65390 IS ADDRESS OF TRANSMITTER DATA BUFFER
330 FOK 65388,4
340 FOK 54390,N
350 REM NUMBER N SENT TO DATA GRABBER
500 REM READ DIGITAL OUTPUT IN A LOOP
510 REM 65384 IS RECEIVER STATUS REGISTER ADDRESS
520 REM 65386 IS RECEIVER INPUT DATA BUFFER
530 REM BEGIN LOOP
540 REM SET UP INTERFACE TO READ IN ONE BYTE
550 FOK 65384,1
560 FOK 65384,0
570 REM READ BYTE AND STORE IN A
580 A=PEEK(65386)
590 REM NEXT SET TO +10 VOLT INPUT FULL SCALE
600 B=10*(A/255)
700 PRINT B;
710 REM SCALED INPUT IS PRINTED ON CRT AS VOLTAGE 0-10 VOLTS
720 REM END OF ONE INPUT LOOP
730 GO TO 530
1000 REM HEATH H-11 PAPER TAPE BASIC. J. C. ROOS JUNE 80
```

Listing 1. A BASIC program for sending command words to the Data Grabber during checkout.

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four bits represent the input address, the next two select the gain and the last one selects the input mode. The number which BASIC pokes to the A/D is the sum of the decimal equivalents of these binary bits. If $N=0$ then input 0 is selected, the gain is 1 and the unipolar mode is selected. If $N=16$, then the input 0 is selected, the gain is 2 and the unipolar mode is selected. Adding 64 to N (the decimal equivalent of bit 6) switches to the bipolar mode.

To state it more formally, $N=A+G+M$, where A is the address and ranges from 0 to 15. G is the gain and has four values: 0 for a gain of 1, 16 for a gain of 2, 32 for a gain of 4 and 48 for a gain of 10. M , the mode select bit equivalent, is 0 for unipolar inputs and 64 for bipolar signals. In a running program any combination of these may be sent to the A/D in any sequence.

Your control program may be tested by sending commands to the A/D converter and observing the LED display. Once this is working, the step-gain amplifier can be calibrated.

The first step is to null the amplifier offset. Have the computer command the A/D for a gain of 10 with input 0 selected. Ground input 0. Then adjust R45 for a zero voltage output from J3. If you cannot null the output exactly, at least obtain a voltage less than 20 mV. This is less than one-half of one LSB.

Next, command a gain of 4 with input 0 selected. Verify that the offset remains less than 20 mV for this input amplifier. If it does, proceed. If it does not, then the input amplifiers of the 2405 are sufficiently different that a second pot will have to be installed to control the voltage applied to R47.

Once the offsets are nulled for the high gain inputs, the amplifier gains are set up. A good digital multimeter and a variable voltage source are required. The DMM should have a specified accuracy and resolution of at least 0.1 percent or better. Remember, the Data Grabber is good for 0.5 percent. You need to calibrate it with something much better than that if the calibration device is not to contribute to the ultimate measurement error.

Program the Data Grabber for a gain of 2 with input 0 selected. Apply an input of exactly 5.00 V dc. Set R30 for a +10.00 V output from J3.

Next, program a gain of 4 with input 0 selected. Apply exactly 2.500 V

to input 0. Adjust R27 for a 10.00 V output at J3. Finally, program a gain of 10. Repeat the adjustment process with an input of 1.000 V and set R24 for a 10.00 V output.

Repeatedly check both the input and output to ensure that nothing drifts during the measurement. Your voltage source should have an output impedance of less than 1k to prevent bias current errors.

Verify that all voltages and loads presented to the ADC 82 are correct and insert it into its socket with the power off. Using your control program and the computer, test for proper operation by selecting the various inputs, gains and modes. Connect the DMM to the variable voltage source and ensure that the number displayed on the computer correctly tracks the input voltage.

It is useful to examine the parallel data lines to the computer. They should be free of any ringing and overshoot when the DSL line goes low.

Conclusion

Construction of the Data Grabber will provide a useful building block for a variety of computer-based projects. The design permits considerable freedom for modification to individual requirements. Here are some ideas.

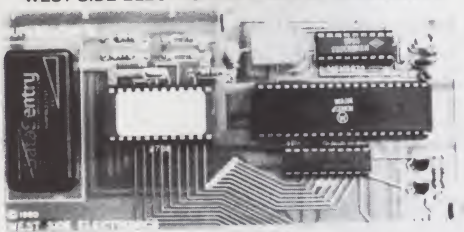
Reduction of the timing period of the delay one shots will enable the circuit to operate much faster. With short lines from the A/D to the computer, the delays may be set to 500 ns or less. Then your problem is getting the software to cycle at a 4 us rate. Generally, the computer software, not the A/D converter, will set the operating speed. If the unit is controlled with assembly-language routines, it may be useful to reduce the delay times. If you drive the unit with software in BASIC, it will be much faster than the software.

As only seven of the eight possible control bits are used, it is easy to expand the input multiplexer. An additional bit and some gates for decoding would permit up to 32 input channels.

In writing this article I have tried to explain the reasons for most features of the design. Evaporation of the basic accuracy of the A/D converter is a subtle problem and one which is not often discussed. With the information presented, you should be able to use my design as is, or as a starting point for your own creation. ■

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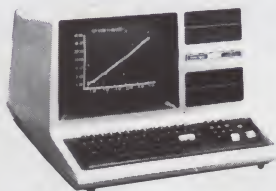
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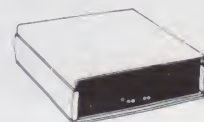
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Expand PET Memory

By Gary L. Ratliff

It is possible to get added memory for larger application programs by using the PET's ability to call into memory another program. This ability is also possible with several popular computers which have Microsoft BASIC.

This technique has its pitfalls, the most obvious of which is that you can crash the system by having a small program call and try to execute a much larger program. My technique for circumventing these problems is designed for the PET computer, but should also help owners of other systems find similar routines for their computers.

Variable Storage Area

To design a system of programs which will call into memory and execute subprograms, you must know how to pass parameters from one program to another. To understand this, you have to know how variables are stored internally in the PET. Listing 1 gives a dump of the contents of the variable table, in the proper format for easy interpretation by the user. It also dumps the contents of the program and variable table in screens which contain 32 bytes each.

In Listing 1, lines 10-40 set up examples of the four types of simple variables: user functions, strings, floating point constants and integer constants. In line 110, I is used as both the format control variable and

```
10 DEF FNA(X)=INT(X/256):DEF FNB(X)=(X/256-FNA(X))*256
20 A$="ABC":B$="CDE":B$=B$+" "
30 A=1:B=-1:AB=281:BA=-281
40 A%=1:B%=-1:AB%=281:BA%=-281
100 GOSUB 300
105 FOR J=PEEK(124)+256*PEEK(125) TO PEEK(126)+256*PEEK(127) STEP 7:PRINT
110 FOR I=0 TO 36 STEP 6
115 PRINT TAB(I);STR$(PEEK(J+INT(I/6)))
120 NEXT I:IF PEEK(225)=131 THEN M=1:GOSUB 500
130 PRINT:NEXT M=2:PRINT"END OF TABLE":GOSUB 500
200 FOR X=1024 TO PEEK(126)+256*PEEK(127) STEP 2
205 PRINT TAB(0);PEEK(X);TAB(7);FNB(X);TAB(14);FNA(X);TAB(22);PEEK(X+1);TAB(29);FNB(X
+1);TAB(36);FNA(X+1)
210 IF PEEK(225)=131 THEN GOSUB 500
211 REM GO
215 NEXT I:PRINT"END OF TABLE":END
300 L=L+1
301 PRINT"#####BASIC VARIABLE TABLE":PRINT"SCREEN #";L:PRINT
305 PRINT"#####":RETURN
400 P=P+1:IF X=256*PEEK(125) THEN 402
401 PRINT"#####PROGRAM AND VARIABLE STORAGE":PRINT"SCREEN #";P:GOTO 410
402 PRINT"#####PROGRAM AND VARIABLE STORAGE":PRINT"SCREEN #";P
410 PRINT"DATA#####LOC.#####PAGE#####DATA#####LOC.#####PAGE":RETURN
500 PRINT:PRINT"WHIT ANY KEY TO CONTINUE"
505 GET A$:IF A$="" THEN 505
510 ON M GOSUB 300,400
515 RETURN
```

Listing 1. Variable storage area formatted dump (old ROMs). Line 211 is entered as 211 REM k. On the old PETs it will stop the screen listing when a LIST is given but have no effect during a run. 211 REM l will do the same thing for new PETs but those with printers will find this unnecessary as it will also stop a printer.

Listing 1a. Variable storage formatted dump (new ROMs).

```
10 DEF FNA(X)=INT(X/256):DEF FNB(X)=(X/256-FNA(X))*256
20 A$="ABC":B$="CDE":B$=B$+" "
30 A=1:B=-1:AB=281:BA=-281
40 A%=1:B%=-1:AB%=281:BA%=-281
100 GOSUB 300
105 FOR J=PEEK(42)+256*PEEK(43) TO PEEK(44)+256*PEEK(45) STEP 7:PRINT
110 FOR I=0 TO 36 STEP 6
115 PRINT TAB(I);STR$(PEEK(J+INT(I/6)))
120 NEXT I:IF PEEK(197)=131 THEN M=1:GOSUB 500
130 PRINT:NEXT M=2:PRINT"END OF TABLE":GOSUB 500
200 FOR X=1024 TO PEEK(44)+256*PEEK(45) STEP 2
205 PRINT TAB(0);PEEK(X);TAB(7);FNB(X);TAB(14);FNA(X);TAB(22);PEEK(X+1);TAB(29);FNB(X
+1);TAB(36);FNA(X+1)
210 IF PEEK(197)=131 THEN GOSUB 500
215 NEXT I:PRINT"END OF TABLE":END
300 L=L+1
301 PRINT"#####BASIC VARIABLE TABLE":PRINT"SCREEN #";L:PRINT
305 PRINT"#####":RETURN
400 P=P+1:IF X=256*PEEK(43) THEN 402
401 PRINT"#####PROGRAM AND VARIABLE STORAGE":PRINT"SCREEN #";P:GOTO 410
402 PRINT"#####PROGRAM AND VARIABLE STORAGE":PRINT"SCREEN #";P
```

More

Address correspondence to Gary L. Ratliff, 1033 Hattiesburg Drive, Magee, MS 39111.

Listing 1a continued.

```
410 PRINT"DATA###LOC.###PAGE###DATA###LOC.###PAGE":RETURN
500 PRINT:PRINT"HIT ANY KEY TO CONTINUE"
505 GETA$:IFA$=""THEN505
510 ON M GOSUB300,400
515 RETURN
```

LISTING 1A WITH PAGINATION ON LISTING ADDED VIA LINE 211

```
10 DEFFNA(X)=INT(X/256):DEFFNB(X)=(X/256-FNA(X))*256
20 A$="ABC":B$="CDE":B$=B$+" "
30 A=1:B=-1:AB=281:BA=-281
40 A%=1:B%=-1:AB%=281:BA%=-281
100 GOSUB300
105 FORJ=PEEK(42)+256*PEEK(43)TOPEEK(44)+256*PEEK(45)STEP7:PRINT
110 FORI=0TO36STEP6
115 PRINTTAB(I)STR$(PEEK(J+INT(I/6)))
120 NEXT I:IFPEEK(197)=131THENM=1:GOSUB500
130 PRINT:PRINTNEXT M=2:PRINT"END OF TABLE":GOSUB500
200 FORX=1024TOPEEK(44)+256*PEEK(45)STEP2
205 PRINTTAB(0)PEEK(X):TAB(7)FNB(X):TAB(14)FNA(X):TAB(22)PEEK(X+1):TAB(29)FNB(X
+1):TAB(36)FNA(X+1)
210 IFPEEK(197)=131THENGOSUB500
211 REM

215 NEXT:PRINT"END OF TABLE":END
300 L=L+1
301 PRINT"#####BASIC VARIABLE TABLE":PRINT"SCREEN #":L:PRINT
305 PRINT"#####"
400 P=P+1:IFX>256*PEEK(43)THEN402
401 PRINT"#####PROGRAM AND VARIABLE STORAGE":PRINT"SCREEN #":P:GOTO410
402 PRINT"#####PROGRAM AND VARIABLE STORAGE":PRINT"SCREEN #":P
410 PRINT"DATA###LOC.###PAGE###DATA###LOC.###PAGE":RETURN
500 PRINT:PRINT"HIT ANY KEY TO CONTINUE"
505 GETA$:IFA$=""THEN505
510 ON M GOSUB300,400
515 RETURN
```

the index pointer indicating the byte to be printed to the screen. The STR\$ function in line 115 prevents the PET from printing a trailing blank space should a numeric value instead of the equivalent string value be printed.

If bit 7 is on, the ASCII value of the variable is ORED with 128 to produce its ultimate code. For example, the variable AA may represent a function name, a string, a floating point constant or an integer constant.

ASCII code for A is 65. If this value is ORED with 128, it becomes 193. In Table 1, you can see that the designation 65 65 means the floating point value AA; the designation 65 193 means the string value AA; the designation 193 65 means the function AA; and the designation 193 193 means the integer value AA.

Next, let's examine the output of Listing 1 to see how the PET deals with each type of variable.

Listing 1 also has two automatic pagination features. In the old PET, memory location 225 contains the page number printed to the screen

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```
SCREEN # 1 BASIC VARIABLE TABLE
6 5 4 3 2 1 0
193 0 12 4 7 9 191 FNA
88 0 0 0 0 0 0 X
194 0 28 4 7 9 40 FNB
65 128 3 54 4 0 0 AS
66 128 3 78 126 0 0 BS
65 0 129 0 0 0 0 A
66 0 129 128 0 0 0 B
65 66 137 12 128 0 0 AB
HIT ANY KEY TO CONTINUE
```

Fig. 1. Output of Listing 1b, screen 1.

```
SCREEN # 2 BASIC VARIABLE TABLE
6 5 4 3 2 1 0 BA
66 65 137 140 128 0 0
193 128 0 1 0 0 0 A%
194 128 255 255 0 0 0 B%
193 194 1 25 0 0 0 AB%
194 193 254 231 0 0 0 BA%
67 82 144 0 0 0 0 CRT
87 68 134 32 0 0 0 WD
76 0 130 0 0 0 0 L
HIT ANY KEY TO CONTINUE
```

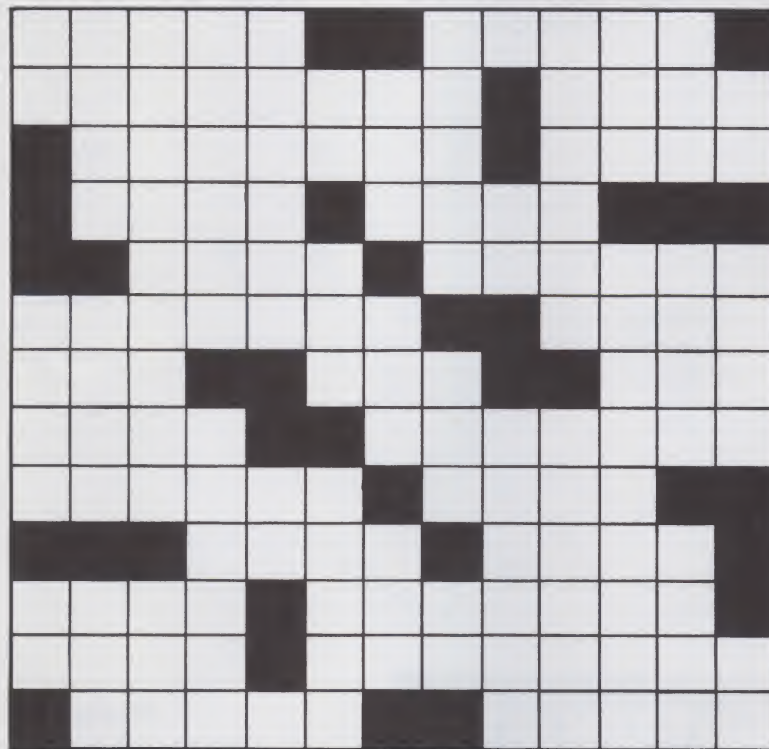
Fig. 2. Output of Listing 1b, screen 2.

```
SCREEN # 3 BASIC VARIABLE TABLE
6 5 4 3 2 1 0
74 0 140 22 224 0 0 J
73 0 132 16 0 0 0 I
END OF TABLE
HIT ANY KEY TO CONTINUE
```

Fig. 3. Output of Listing 1b, screen 3.

SCREEN DATA	LOC.	PAGE	DATA	LOC.	PAGE
1	128	1	128	1	1
2	129	1	129	1	1
3	130	1	130	1	1
4	131	1	131	1	1
5	132	1	132	1	1
6	133	1	133	1	1
7	134	1	134	1	1
8	135	1	135	1	1
9	136	1	136	1	1
10	137	1	137	1	1
11	138	1	138	1	1
12	139	1	139	1	1
13	140	1	140	1	1
14	141	1	141	1	1
15	142	1	142	1	1
16	143	1	143	1	1
17	144	1	144	1	1
18	145	1	145	1	1
19	146	1	146	1	1
20	147	1	147	1	1
21	148	1	148	1	1
22	149	1	149	1	1
23	150	1	150	1	1
24	151	1	151	1	1
25	152	1	152	1	1
26	153	1	153	1	1
27	154	1	154	1	1
28	155	1	155	1	1
29	156	1	156	1	1
30	157	1	157	1	1
31	158	1	158	1	1
32	159	1	159	1	1
33	160	1	160	1	1
34	161	1	161	1	1
35	162	1	162	1	1
36	163	1	163	1	1
37	164	1	164	1	1
38	165	1	165	1	1
39	166	1	166	1	1
40	167	1	167	1	1
41	168	1	168	1	1
42	169	1	169	1	1
43	170	1	170	1	1
44	171	1	171	1	1
45	172	1	172	1	1
46	173	1	173	1	1
47	174	1	174	1	1
48	175	1	175	1	1
49	176	1	176	1	1
50	177	1	177	1	1
51	178	1	178	1	1
52	179	1	179	1	1
53	180	1	180	1	1
54	181	1	181	1	1
55	182	1	182	1	1
56	183	1	183	1	1
57	184	1	184	1	1
58	185	1	185	1	1
59	186	1	186	1	1
60	187	1	187	1	1
61	188	1	188	1	1
62	189	1	189	1	1
63	190	1	190	1	1
64	191	1	191	1	1
65	192	1	192	1	1
66	193	1	193	1	1
67	194	1	194	1	1
68	195	1	195	1	1
69	196	1	196	1	1
70	197	1	197	1	1
71	198	1	198	1	1
72	199	1	199	1	1
73	200	1	200	1	1
74	201	1	201	1	1
75	202	1	202	1	1
76	203	1	203	1	1
77	204	1	204	1	1
78	205	1	205	1	1
79	206	1	206	1	1
80	207	1	207	1	1
81	208	1	208	1	1
82	209	1	209	1	1
83	210	1	210	1	1
84	211	1	211	1	1
85	212	1	212	1	1
86	213	1	213	1	1
87	214	1	214	1	1
88	215	1	215	1	1
89	216	1	216	1	1
90	217	1	217	1	1
91	218	1	218	1	1
92	219	1	219	1	1
93	220	1	220	1	1
94	221	1	221	1	1
95	222	1	222	1	1
96	223	1	223	1	1
97	224	1	224	1	1
98	225	1	225	1	1
99	226	1	226	1	1
100	227	1	227	1	1
101	228	1	228	1	1
102	229	1	229	1	1
103	230	1	230	1	1
104	231	1	231	1	1
105	232	1	232	1	1
106	233	1	233	1	1
107	234	1	234	1	1
108	235	1	235	1	1
109	236	1	236	1	1
110	237	1	237	1	1
111	238	1	238	1	1
112	239	1	239	1	1
113	240	1	240	1	1
114	241	1	241	1	1
115	242	1	242	1	1
116	243	1	243	1	1
117	244	1	244	1	1
118	245	1	245	1	1
119	246	1	246	1	1
120	247	1	247	1	1
121	248	1	248	1	1
122	249	1	249	1	1
123	250	1	250	1	1
124	251	1	251	1	1
125	252	1	252	1	1
126	253	1	253	1	1
127	254	1	254	1	1
128	255	1	255	1	1
129	256	1	256	1	1
130	257	1	257	1	1
131	258	1	258	1	1
132	259	1	259	1	1
133	260	1	260	1	1
134	261	1	261	1	1
135	262	1	262	1	1
136	263	1	263	1	1
137	264	1	264	1	1
138	265	1	265	1	1
139	266	1	266	1	1
140	267	1	267	1	1
141	268	1	268	1	1
142	269	1	269	1	1
143	270	1	270	1	1
144	271	1	271	1	1
145	272	1	272	1	1
146	273	1	273	1	1
147	274	1	274	1	1
148	275	1	275	1	1
149	276	1	276	1	1
150	277	1	277	1	1
151	278	1	278	1	1
152	279	1	279	1	1
153	280	1	280	1	1
154	281	1	281	1	1
155	282	1	282	1	1
156	283	1	283	1	1
157	284	1	284	1	1
158	285	1	285	1	1
159	286	1	286	1	1
160	287	1	287	1	1
161	288	1	288	1	1
162	289	1	289	1	1
163	290	1	290	1	1
164	291	1	291	1	1
165	292	1	292	1	1
166	293	1	293	1	1
167	294	1	294	1	1
168	295	1	295	1	1
169	296	1	296	1	1
170	297	1	297	1	1
171	298	1	298	1	1
172	299	1	299	1	1
173	300	1	300	1	1
174	301	1	301	1	1
175	302	1	302	1	1
176	303	1	303	1	1
177	304	1	304	1	1
178	305	1	305	1	1
179	306	1	306	1	1
180	307	1	307	1	1
181	308	1	308	1	1
182	309	1	309	1	1
183	310	1	310	1	1
184	311	1	311	1	1
185	312	1	312	1	1
186	313	1	313	1	1
187	314	1	314	1	1
188	315	1	315	1	1
189	316	1	316	1	1
190	317	1	317	1	1
191	318	1	318	1	1
192	319	1	319	1	1
193	320	1	320	1	1
194	321	1	321	1	1
195	322	1	322	1	1
196	323	1	323	1	1
197	324	1	324	1	1
198	325	1	325	1	1
199	326	1	326	1	1
200	327	1	327	1	1
201	328	1	328	1	1
202	329	1	329	1	1
203	330	1	330	1	1
204	331	1	331	1	1
205	332	1	332	1	1
206	333	1	333	1	1
207	334	1	334	1	1
208	335	1	335	1	1
209	336	1	336	1	1
210	337	1	337	1	1
211	338	1	338	1	1
212	339	1	339	1	1
213	340	1	340	1	1
214	341	1	341	1	1
215	342	1	342	1	1
216	343	1	343	1	1
217	344	1	344	1	1
218	345	1	345	1	1
219	346	1	346	1	1
220	347	1	347	1	1
221	348	1	348	1	1
222	349	1	349	1	1
223	350	1	350	1	1
224	351	1	351	1	1
225	352	1	352	1	1
226	353	1	353	1	1
227	354	1	354	1	1
228	355	1	355	1	1
229	356	1	356	1	1
230	357	1	357	1	1
231	358	1	358	1	1
232	359	1	359	1	1
233	360	1	360	1	1
234	361	1	361	1	1
235	362	1	362	1	1
236	363	1	363	1	1
237	364	1	364	1	1
238	365	1	365	1	1
239	366	1	366	1	1
240	367	1	367	1	1
241	368	1	368	1	1
242	369	1	369	1	1
243	370	1	370	1	1
244	371	1	371	1	1
245	372	1	372	1	1
246	373	1	373	1	1
247	374	1	374	1	1
248	375	1	375	1	1
249	376	1	376	1	1
250	377	1	377	1	1
251	378	1	378	1	1
252	379	1	379	1	1
253	380	1	380	1	1
254	381	1	381	1	1
255	382	1	382	1	1
256	383	1	383	1	1
257	384	1	384	1	1
258	385	1	385	1	1
259	386	1	386	1</	

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program is changed, as in line 0, I found that the first run of the program would produce unusual output which could be corrected by running the program again. The directed run corrects this problem.

To observe this distortion, add a line 10 to Listing 2 so that one of the values from lines 106 to 110 is used to alter the program size after it is running (e.g., make line 10 POKE 124, 161 : POKE 125,14). Then run the program. Now run the program again, and the funny output to the screen is replaced by the correct output.

Listing 2 is an extension of the idea of making a system of programs size-compatible. Here, a menu is adjusted to the size of the program selected. This is an automatic directory system for your cassettes. The data is changed to the programs that are on the multi-program file which you create.

As written, Listing 2 has to be run twice to be successful. Subroutine 105 plays "hide and seek" with the variable table. The first pass through the routine sets the memory size of the menu program to that of the pro-

gram you want to run. When the PET looks into this location, it doesn't find the variable table there and returns with an error:

ILLEGAL QUANTITY ERROR IN 90.

When this program is run again, the variable table has been relocated to the program you selected, and the PET loads and executes this program.

Modifications

A method of correcting this problem, using the dynamic keyboard and PET shorthand, might be better than having to run the program twice. The dynamic keyboard is discussed in the "Cover Up" article. There are several unused bytes in the PET, from the end of the second cassette buffer to the start of the BASIC text area of memory.

One of these is used to store the value of the program selected, and another is used as a flag bit to indicate if you are in pass one or pass two of the program. The dynamic keyboard will be set up with the text Ru5 (short-hand for RUN5).

At the end of the first pass, the error condition will stop the program.

But the statement RUN 5 in the dynamic keyboard will restart the program, and now, instead of being input, the value we selected as J will be entered from the storage area, and the selected program from the menu will be loaded and will execute.

The changes needed in Listing 2 to do this are:

```
change line 0 to line 5
add line 0: 0 POKE 1018,5
change line 80 to: 80 IF PEEK 1018=5 THEN
INPUT(3dnENTER(rev)NUMBER(off) OF
CHOICE";J:POKE 1019,J
add line 85: 85 IF PEEK 1018=10 THEN J=
PEEK(1019)
change the reference in line 90 from Gosub 105
to GOSUB 103
add line 103: 103 IF PEEK (1018)=5 THEN
POKE 1018,10: GOSUB 200
add the dynamic keyboard initialization sub-
routine by adding line 200: 200 POKE525,4:
POKE527,82:POKE528,213:POKE529,53:
POKE530,13:RETURN
(The keyboard buffer on the new PETs is
moved from 527-536 to 623-632. This line
would become 200 POKE 158,4:POKE 623,82:
POKE 624,213:POKE 625,53:POKE 626,13:RE-
TURN.)
```

These modifications will cause the directory program to run without the operator restarting it.



106

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```

0 PRINT "J"
20 DATA 5,22,11,COVER,3K,TIC-TAC-TOE,6K,DISCO,6K,ADFLAG,1K,RDS,6K,EXIT MENU
30 READ P,M,1:DIMA$(I)
40 PRINT "NO.":TAB(P)"PROGRAM NAME";TAB(M)"MEMORY SIZE":PRINT "J"
50 FOR J=1 TO I:READ A$(J):NEXT
60 FOR J=1 TO I-1:STEP 2:PRINT (J+1)/2:TAB(P)A$(J):TAB(M)A$(J+1):NEXT
70 PRINT (J+1)/2:TAB(P)"J":A$(J):"J"
80 INPUT "ENTER NUMBER OF CHOICE";J
90 IF LEFT$(A$(J*2-1),4)<>"EXIT" THEN GOSUB 105:LOAD A$(2*J-1)
100 END
105 ON J GOTO 106,107,108,109,110
106 POKE 124,161:POKE 125,14:RETURN
107 POKE 124,152:POKE 125,21:RETURN
108 POKE 124,160:POKE 125,24:RETURN
109 POKE 124,101:POKE 125,07:RETURN
110 POKE 124,154:POKE 125,24:RETURN

```

Adjustment for 3.0 ROMs and 4.0 BASIC.
106 POKE 42, 161: POKE 43,14 : RETURN
107 POKE 42, 152: POKE 43,21 : RETURN
108 POKE 42, 160: POKE 43,24 : RETURN
109 POKE 42, 101: POKE 43,07 : RETURN
110 POKE 42, 154: POKE 43,24 : RETURN

Listing 2. Executive directory.

Another change you might want to add to the cassette directory program while setting it up for your own cassette programs, is a fast-forward subroutine. This will reduce the waiting time when you select a program which is well down the line in the cassette. The "Cover Up" article contains such a fast-forward routine.

William Pytlik's "Case of the Missing Tape Counter" (June 1979 *Micro*) presents in detail a fast-forward timed routine for improving the speed of finding cassette programs.

In conclusion, the command LOAD is the key to increasing the length of your application programs. The ability to pass parameters cor-

rectly from one program to another, and the ability to correct the size-incompatibility problem, should enable you to use the memory contained in your system to greater advantage. ■

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MICRO QUIZ

(from page 30)

Answer: (1,1,1,0), (1,0,1,1), (1,0,0,1) and (1,0,0,0) A must be true. The following truth table yields the values for B, C and D.

B	C	D	CD	(CD) ⊕ B
0	0	0	1	1
0	0	1	1	1
0	1	0	0	0
0	1	1	1	1
1	0	0	1	0
1	0	1	1	0
1	1	0	0	1
1	1	1	1	0

Applefest Comes to Boston

Applefest '81, devoted exclusively to the Apple computers, will take place Saturday and Sunday, June 6 and 7, 1981, at the Plaza Castle, Arlington St., Boston, MA. Over 100 exhibits of Apple computers, software, peripherals, accessories, applications and services will be featured. Free seminars will run the two days of the show. Admission is \$3 per day.

Applefest '81 is sponsored by Apple/Boston, the Boston Computer Society's Apple user group. For information or tickets, contact: The Boston Computer Society, Three Center Plaza, Boston, MA 02108, 617-367-8080.

Los Angeles Shows

The Business and Personal Computer Sales Expo and the Los Angeles Business Show will be held at the Los Angeles Convention Center from July 9-11. For further information, contact Produx 2000, Inc., Box 2000, Bala Cynwyd, PA 19004.

CLUB NOTES

Tulsa Computer Society

The Tulsa Computer Society meets on the last Tuesday of each month at the Tulsa Vocational-Technical School (3420 S. Memorial Drive) at 7:30 PM. Contact the society at PO Box 1133, Tulsa, OK 74101.

Tallahassee Computerists

The Tallahassee Amateur Computer Society (TACS) meets on the second Thursday of the month to explore the uses of small computer systems for educational, business and personal applications. Write to the Tallahassee Amateur Computer Society, PO Box 6717, Tallahassee, FL 32301, for further information.

Permian Basin Club

The Permian Basin Amateur Computer Group meets on the second Tuesday of each month in Midland, TX, in the Midland College Student Center at 7:30 PM and in Odessa, TX, on the second Saturday of each month at 1 PM in the Odessa College Electronics Technology Building. This group was recently organized to exchange information on small computers and to pro-

vide technical assistance on computer projects. Contact the Permian Basin Amateur Computer Group, c/o John Rabenaldt, Ector County School District, Box 3912, Odessa, TX 79760.

Attention, Robot Enthusiasts

David Smith is interested in forming a club in the New York City area for anyone interested in building or working with robots. If you are interested in joining such a club, contact David at 45405 Kennedy Blvd., North Bergen, NJ 07047 (201-856-4890).

Toronto Computer Enthusiasts

The Toronto Region Association of Computer Enthusiasts (TRACE) holds two meetings each month: at the Ontario Science Center, 770 Don Mills Road, Don Mills, at 2 PM on the second Sunday of each month; and on the fourth Friday of each month in Room J206, Humber College, Rexdale, at 7:30 PM. For further information, contact the Toronto Region Association of Computer Enthusiasts, PO Box 6922, Station A, Toronto, Ontario, M5M 1X6, Canada.

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Wanted: Bare printed circuit board for D. C. Hayes 80-103A modem. Contact D. Reinebeck, 899 Fairfield Rd., North Vancouver, B. C., V7H 2J4, Canada. 604-929-5759, Telex 04-352544.

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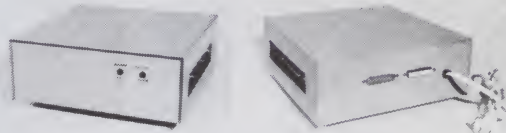
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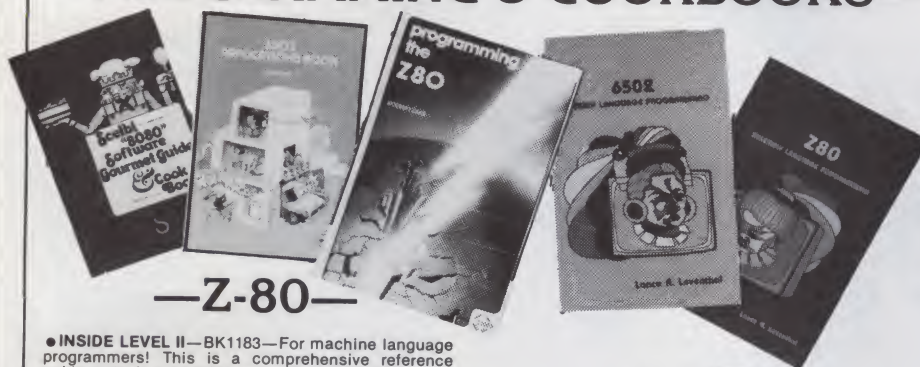
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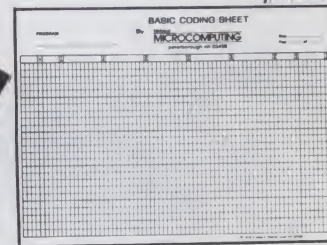
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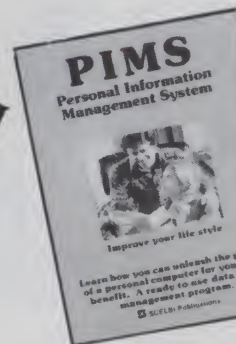
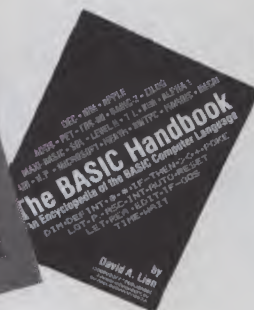
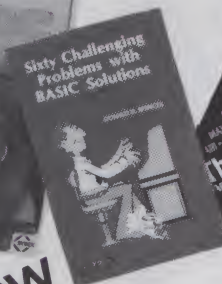
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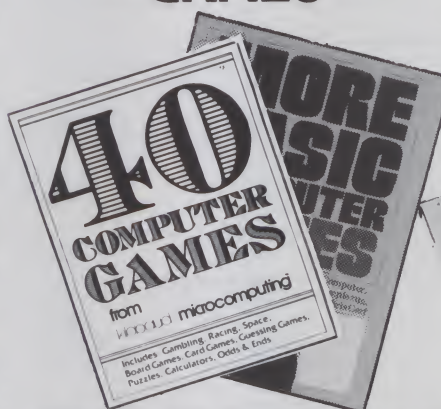
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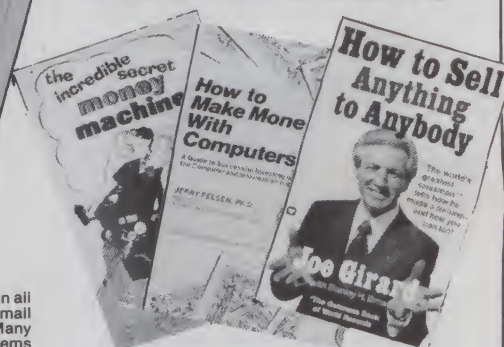
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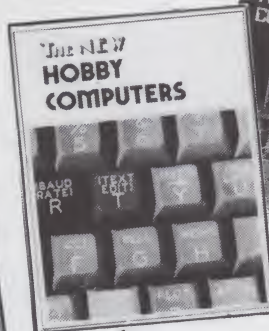
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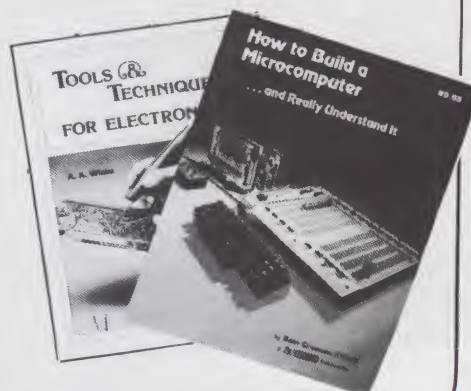
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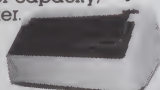
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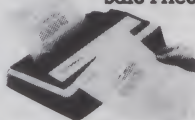
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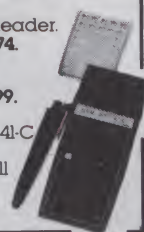
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
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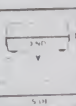
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
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SN7409N	.29	SN7482N	.99	SN74167N	2.79
SN7410N	.25	SN7483N	.99	SN74170N	1.95
SN7411N	.29	SN7485N	.89	SN74172N	4.95
SN7412N	.35	SN7486N	.35	SN74173N	1.39
SN7413N	.40	SN7489N	1.75	SN74174N	.99
SN7414N	.69	SN7490N	.49	SN74175N	.89
SN7416N	.29	SN7491N	.59	SN74176N	.79
SN7417N	.25	SN7492N	.45	SN74177N	.79
SN7418N	.25	SN7493N	.45	SN74178N	1.49
SN7419N	.25	SN7494N	.69	SN74179N	2.49
SN7421N	.25	SN7495N	.69	SN74180N	2.25
SN7422N	.25	SN7496N	.69	SN74181N	.79
SN7423N	.25	SN7497N	3.00	SN74182N	.79
SN7424N	.25	SN74100N	1.49	SN74184N	2.49
SN7425N	.25	SN74101N	.35	SN74185N	2.69
SN7426N	.25	SN74109N	.35	SN74190N	1.25
SN7427N	.25	SN74116N	1.95	SN74191N	1.25
SN7428N	.49	SN74121N	.39	SN74192N	.89
SN7429N	.25	SN74122N	.59	SN74193N	.89
SN7430N	.40	SN74123N	.59	SN74194N	.89
SN7431N	.25	SN74126N	.59	SN74195N	.89
SN7432N	.25	SN74132N	.75	SN74197N	.89
SN7433N	.25	SN74136N	.75	SN74198N	1.49
SN7434N	.110	SN74141N	.99	SN74199N	1.25
SN7441N	.110	SN74142N	.99	SN74221N	1.69
SN7444N	.89	SN74143N	3.49	SN74251N	1.95
SN7445N	.89	SN74144N	3.49	SN74276N	1.95
SN7446N	.79	SN74145N	.79	SN74279N	.79
SN7447N	.69	SN74147N	1.95	SN74281N	1.49
SN7448N	.79	SN74148N	1.29	SN74284N	3.95
SN7449N	.20	SN74150N	1.25	SN74285N	1.95
SN7451N	.20	SN74151N	.99	SN74365N	.69
SN7453N	.20	SN74152N	.99	SN74366N	.69
SN7454N	.20	SN74153N	.75	SN74367N	.69
SN7459A	.25	SN74155N	1.25	SN74368N	.69
SN7460A	.25	SN74156N	1.25	SN74369N	1.49
SN7461A	.25			SN74393N	1.49

A P PRODUCTS

DIP JUMPERS



- Made with Standard IC Sockets
- Fully Assembled and Tested
- Integral Molded-On Strain Relief
- Line By-Line Probability

Dip Jumpers are used for jump wiring within a PCB board, interconnecting between PC boards, backplanes and mother boards, and interfacing input/output signals.

DISCRETE LEDS

Part No.	No. of Contacts	Wire Length	Price
924102-12	14 single end	12"	\$1.51
924102-24	14 double end	12"	1.52
924102-36	14 triple end	12"	2.33
924102-48	14 quadruple end	12"	3.02
924102-60	14 double end	24"	3.43
924102-72	14 single end	24"	1.67
924112-24	16 single end	24"	2.13
924112-36	16 double end	12"	2.88
924112-48	16 double end	24"	3.34
924112-60	16 double end	36"	3.80
924112-72	24 single end	12"	2.60
924112-84	24 single end	24"	3.25
924122-24	24 single end	36"	4.00
924122-36	24 double end	12"	4.50
924122-48	24 double end	24"	5.35
924122-60	24 single end	12"	4.35
924122-72	40 single end	36"	6.71

DISPLAY LEDS

C.A. - Common Anode			C.C. - Common Cathode		
Type	Polarity	Price	Type	Polarity	Price
MAN 1	C.A.-red	270 2.95	DLG507	C.C.-green	.500 1.25
MAN 2	5x7 D.M.-red	300 4.95	DLJ04	C.C.-red	.300 1.25
MAN 3	C.C.-red	125 .25	DLJ07	C.C.-red	.300 1.25
MAN 4	C.A.-green	300 1.25	DLJ28	C.C.-red	.600 1.49
MAN 5	C.C.-green	300 1.25	DLJ41	C.C.-red	.600 1.25
MAN 6	C.A.-red	300 .75	DLJ46	C.A.-red ± 1	.630 1.49
MAN 7	C.A.-red	300 1.25	DLJ50	C.C.-red	.600 1.49
MAN 8	C.C.-yellow	300 .49	DLJ57	C.C.-orange	.800 1.49
MAN 9	C.A.-orange	300 .49	DLJ60	C.C.-orange	.800 1.49
MAN 10	C.A.-orange ± 1	300 .99	DLJ63	C.C.-red	.110 .35
MAN 11	C.A.-orange	300 .99	DLJ68	C.C.-red	.357 .99
MAN 12	C.A.-orange	300 .99	DLJ73	C.C.-red	.357 .99
MAN 13	C.A.-orange	300 .99	DLJ78	C.C.-red	.357 .99
MAN 14	C.A.-orange	300 .99	DLJ83	C.C.-red	.357 .99
MAN 15	C.A.-orange	300 .99	DLJ88	C.C.-red	.357 .99
MAN 16	C.A.-orange	300 .99	DLJ93	C.C.-red	.357 .99
MAN 17	C.A.-orange	300 .99	DLJ98	C.C.-red	.357 .99
MAN 18	C.A.-orange	300 .99	DLJ03	C.C.-red	.357 .99
MAN 19	C.A.-orange	300 .99	DLJ08	C.C.-red	.357 .99
MAN 20	C.A.-orange	300 .99	DLJ13	C.C.-red	.357 .99
MAN 21	C.A.-orange	300 .99	DLJ18	C.C.-red	.357 .99
MAN 22	C.A.-orange	300 .99	DLJ23	C.C.-red	.357 .99
MAN 23	C.A.-orange	300 .99	DLJ28	C.C.-red	.357 .99
MAN 24	C.A.-orange	300 .99	DLJ33	C.C.-red	.357 .99
MAN 25	C.A.-orange	300 .99	DLJ38	C.C.-red	.357 .99
MAN 26	C.A.-orange	300 .99	DLJ43	C.C.-red	.357 .99
MAN 27	C.A.-orange	300 .99	DLJ48	C.C.-red	.357 .99
MAN 28	C.A.-orange	300 .99	DLJ53	C.C.-red	.357 .99
MAN 29	C.A.-orange	300 .99	DLJ58	C.C.-red	.357 .99
MAN 30	C.A.-orange	300 .99	DLJ63	C.C.-red	.357 .99
MAN 31	C.A.-orange	300 .99	DLJ68	C.C.-red	.357 .99
MAN 32	C.A.-orange	300 .99	DLJ73	C.C.-red	.357 .99
MAN 33	C.A.-orange	300 .99	DLJ78	C.C.-red	.357 .99
MAN 34	C.A.-orange	300 .99	DLJ83	C.C.-red	.357 .99
MAN 35	C.A.-orange	300 .99	DLJ88	C.C.-red	.357 .99
MAN 36	C.A.-orange	300 .99	DLJ93	C.C.-red	.357 .99
MAN 37	C.A.-orange	300 .99	DLJ98	C.C.-red	.357 .99
MAN 38	C.A.-orange	300 .99	DLJ03	C.C.-red	.357 .99
MAN 39	C.A.-orange	300 .99	DLJ08	C.C.-red	.357 .99
MAN 40	C.A.-orange	300 .99	DLJ13	C.C.-red	.357 .99
MAN 41	C.A.-orange	300 .99	DLJ18	C.C.-red	.357 .99
MAN 42	C.A.-orange	300 .99	DLJ23	C.C.-red	.357 .99
MAN 43	C.A.-orange	300 .99	DLJ28	C.C.-red	.357 .99
MAN 44	C.A.-orange	300 .99	DLJ33	C.C.-red	.357 .99
MAN 45	C.A.-orange	300 .99	DLJ38	C.C.-red	.357 .99
MAN 46	C.A.-orange	300 .99	DLJ43	C.C.-red	.357 .99
MAN 47	C.A.-orange	300 .99	DLJ48	C.C.-red	.357 .99
MAN 48	C.A.-orange	300 .99	DLJ53	C.C.-red	.357 .99
MAN 49	C.A.-orange	300 .99	DLJ58	C.C.-red	.357 .99
MAN 50	C.A.-orange	300 .99	DLJ63	C.C.-red	.357 .99
MAN 51	C.A.-orange	300 .99	DLJ68	C.C.-red	.357 .99
MAN 52	C.A.-orange	300 .99	DLJ73	C.C.-red	.357 .99
MAN 53	C.A.-orange	300 .99	DLJ78	C.C.-red	.357 .99
MAN 54	C.A.-orange	300 .99	DLJ83	C.C.-red	.357 .99
MAN 55	C.A.-orange	300 .99	DLJ88	C.C.-red	.357 .99
MAN 56	C.A.-orange	300 .99	DLJ93	C.C.-red	.357 .99
MAN 57	C.A.-orange	300 .99	DLJ98	C.C.-red	.357 .99
MAN 58	C.A.-orange	300 .99	DLJ03	C.C.-red	.357 .99
MAN 59	C.A.-orange	300 .99	DLJ08	C.C.-red	.357 .99
MAN 60	C.A.-orange	300 .99	DLJ13	C.C.-red	.357 .99
MAN 61	C.A.-orange	300 .99	DLJ18	C.C.-red	.357 .99
MAN 62	C.A.-orange	300 .99	DLJ23	C.C.-red	.357 .99
MAN 63	C.A.-orange	300 .99	DLJ28	C.C.-red	.357 .99
MAN 64	C.A.-orange	300 .99	DLJ33	C.C.-red	.357 .99
MAN 65	C.A.-orange	300 .99	DLJ38	C.C.-red	.357 .99
MAN 66	C.A.-orange	300 .99	DLJ43	C.C.-red	.357 .99
MAN 67	C.A.-orange	300 .99	DLJ48	C.C.-red	.357 .99
MAN 68	C.A.-orange	300 .99	DLJ53	C.C.-red	.357 .99
MAN 69	C.A.-orange	300 .99	DLJ58	C.C.-red	.357 .99
MAN 70	C.A.-orange	300 .99	DLJ63	C.C.-red	.357 .99
MAN 71	C.A.-orange	300 .99	DLJ68	C.C.-red	.357 .99
MAN 72	C.A.-orange	300 .99	DLJ73	C.C.-red	.357 .99
MAN 73	C.A.-orange	300 .99	DLJ78	C.C.-red	.357 .99
MAN 74	C.A.-orange	300 .99	DLJ83	C.C.-red	.357 .99
MAN 75	C.A.-orange	300 .99	DLJ88	C.C.-red	.357 .99
MAN 76	C.A.-orange	300 .99	DLJ93	C.C.-red	.357 .99
MAN 77	C.A.-orange	300 .99	DLJ98	C.C.-red	.357 .99
MAN 78	C.A.-orange	300 .99	DLJ03	C.C.-red	.357 .99
MAN 79	C.A.-orange	300 .99	DLJ08	C.C.-red	.357 .99
MAN 80	C.A.-orange	300 .99	DLJ13	C.C.-red	.357 .99
MAN 81	C.A.-orange	300 .99	DLJ18	C.C.-red	.357 .99
MAN 82	C.A.-orange	300 .99	DLJ23	C.C.-red	.357 .99
MAN 83	C.A.-orange	300 .99	DLJ28	C.C.-red	.357 .99
MAN 84	C.A.-orange	300 .99	DLJ33	C.C.-red	.357 .99
MAN 85	C.A.-orange	300 .99	DLJ38	C.C.-red	.357 .99
MAN 86	C.A.-orange	300 .99	DLJ43	C.C.-red	.357 .99
MAN 87	C.A.-orange	300 .99	DLJ48	C.C.-red	.357 .99
MAN 88	C.A.-orange	300 .99	DLJ53	C.C.-red	.357 .99
MAN 89	C.A.-orange	300 .99	DLJ58	C.C.-red	.357 .99
MAN 90	C.A.-orange	300 .99	DLJ63	C.C.-red	.357 .99
MAN 91	C.A.-orange	300 .99	DLJ68	C.C.-red	.357 .99
MAN 92	C.A.-orange	300 .99	DLJ73	C.C.-red	.357 .99
MAN 93	C.A.-orange	300 .99	DLJ78	C.C.-red	.357 .99
MAN 94	C.A.-orange	300 .99	DLJ83	C.C.-red	.357 .99
MAN 95	C.A.-orange	300 .99	DLJ88	C.C.-red	.357 .99
MAN 96	C.A.-orange	300 .99	DLJ93	C.C.-red	.357 .99
MAN 97	C.A.-orange	300 .99	DLJ98	C.C.-red	.357 .99
MAN 98	C.A.-orange	300 .99	DLJ03	C.C.-red	.357 .99
MAN 99	C.A.-orange	300 .99	DLJ08	C.C.-red	.357 .99
MAN 100	C.A.-orange	300 .99	DLJ13	C.C.-red	.357 .99

SOCKETS

RECEPTACLES

Test TEXTOL

• Nickel Boron Plating
• G.F. PSF Plastic Body
• For testing IC's
• Wire Wrap Contacts

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
214-3339	14 pin	5.95	222-3343	22 pin	9.95	214-3592	14 pin	9.75	222-3596	22 pin	12.95
216-3340	16 pin	6.49	224-3344	24 pin	9.75	216-3593	16 pin	9.95	224-3597	24 pin	15.95
218-3341	18 pin	7.95	226-3345	26 pin	12.95	218-3594	18 pin	10.95	226-3598	26 pin	13.95
220-3342	20 pin	8.95	240-3346	40 pin	12.95	220-3595	20 pin	11.95	240-3599	40 pin	15.95

LOW PROFILE (TIN) SOCKETS

SOLDER TAIL STANDARD (TIN)

1-24	25-49	50-100	1-24	25-49	50-100
8 pin LP	.17	.			

National Semiconductor

Clock Modules

12VDC
AUTOMOTIVE/
INSTRUMENT
CLOCK

APPLICATIONS:
• In-dash autoticks
• After-market auto/
RV clocks
• Aircraft-marine clks.
• 12VDC opar. Instru.
• Portable/battery
powered instrumts.

Features: Bright 0.3" green display. Internal crystal timebase. ± 0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Clock Module \$16.95

CLOCK MODULES

MA1023 .7" Low Cost Digital LED Clock Module	8.95
MA1026 .7" LED Alarm Clock/Thermometer	18.95
MA5036 .3" Low Cost Digital LED Clock/Timer	6.95
MA1002 .5" LED Display Dig. Clock & Xformer	9.95

XFMR1023 Xformer for MA1023 Clock Modules 3.49
XFMR1026 Xformer for MA1026 Clock Modules 3.49
XFMR5036 Xformer for MA5036 Clock Modules 3.49

Transistor Checker

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. It has been specially designed to take advantage of the newest concept of dynamic testing under current amplifier conditions. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. No preliminary set-up is needed. The unit safely and automatically identifies low, medium and high power PNP and NPN transistors. The ASI Transistor Checker also permits matching similar transistors in actual operating circuits, and provides a reliable GO/NO-GO test at practical collector currents (from 5mA on small signal types to 500mA and more on power types). Match similar type transistors by observing and comparing dial readings; the higher the reading, the higher the gain. Completely assembled—battery operated. ("C" cell battery not included.)

Trans-Check \$9.95

EPROM Erasing Lamp

• Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.
• Erases up to 4 chips within 20 minutes.
• Maintains constant exposure distance of one inch.
• Special conductive foam liner eliminates static build-up.
• Built-in safety lock to prevent UV exposure.
• Compact—only 7-5/8" x 2-7/8" x 2"
• Complete with holding tray for 4 chips.

UVS-11E \$79.95

JOYSTICKS

JS-5K
JS-5K 5K Linear Taper Pots \$5.25
JS-100K 100K Linear Taper Pots \$4.95
JVC-40 40 (2) Video Controller in case \$5.95

6-Digit Clock Kit

• Bright .300 ht. comm. cathode display
• Uses MM5314 clock chip
• Switches for hours, minutes and hold modes
• Hrs. easily viewable to 20 ft.
• Simulated walnut case
• 115 VAC operation
• 12 or 24 hr. operation
• Incl. all components, case & wall transformer
• Size: 6 3/4" x 3 1/8" x 1 3/4"

JE701 \$19.95

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
• Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
• Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
• Two, 3 terminal adj. IC regulators with thermal overload protection.
• Heat sink regulator cooling
• LED "on" indicator
• Printed Board Construction
• 120VAC input
• Size: 3-1/2" w x 5-1/16" L x 2" H

JE215 Adj. Dual Power Supply Kit (as shown) . . . \$24.95

(Picture not shown but similar in construction to above)
JE200 Reg. Power Supply Kit (5VDC, 1 amp) . . . \$14.95
JE205 Adapter Brd. (to JE200) ±5.0 & ±12V. \$12.95
JE210 Var. Pwr. Supply Kit, 5-15VDC, to 1.5amp. \$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

IN8080A CPU	4.95
DP212 8-Bit Input/Output	1.95
DP214 Priority Interrupt Control	1.95
DP216 8-Bit Directional Bus Driver	3.49
DP224 Clock Generator/Driver	1.95
DP226 Bus Driver	1.95
DP228 System Controller/Bus Driver	5.95
DP230 System Controller	4.95
DP232 I/O Expander for 48 Series Asynchronous Comm. Element	1.49
DP251 Prog. Comm. I/O (USART)	7.95
DP253 Prog. Peripheral I/O (PPI)	14.95
DP257 Prog. DMA Control	9.95
DP259 Prog. Interrupt Control	14.95
DP275 Prog. CRT Controller	49.95
DP279 Prog. Keyboard/Display Interface	15.95
DP300 Octal Bus Receiver	6.95
DP303 System Timing Element	4.95
DP304 8-Bit Bi-Directional Receiver	3.95
DP306 8-Bit Bi-Directional Receiver	3.95
DP308 8-Bit Bi-Directional Receiver	3.95

8800/6800 SUPPORT DEVICES

MC6800 MPU with Clock and RAM	14.95
MC6802 128K Static RAM	4.95
MC6821 Peripheral Inter. Adapt (MC6820)	1.49
MC6828 Priority Interrupt Controller	3.95
MC6834 10Kx8-Bit ROM (MC6830A)	4.95
MC6860 Asynchronous Comm. Adapter	14.95
MC6862 Synchronous Serial Data Adapter	14.95
MC6866 9400bps Digital MODEM	12.95
MC6862 2400bps Modem	12.95
MC6880A Quad 3-State Bus Trans. (MC6876)	2.25

MICROPROCESSOR CHIPS

Z80 (780) CPU (MH3801) (20pin)	11.95
Z80A (780-1) CPU (MH3801A) (40pin)	11.95
CDP1802 MPU	19.95
CDP1802A MPU	19.95
IN8080A CPU—8-Bit Slice (Com. Temp. Grade)	19.95
MC5802 MPU w/Clock (8K Bytes Memory)	11.95
IN5802N-4 MPU—8-Bit (8Kx12)	16.95
IN5802N-4 CPU—8-Bit (128 Bytes RAM)	19.95
IN5802N-4 CPU (256 Bytes RAM)	24.95
IN5802N-4 CPU—14 Bytes RAM	24.95
IN5802N-4 CPU w/Basic Micro Interpreter	24.95
PM080 CPU—16-Bit	49.95
IN5800 CPU—16-Bit	29.95
TM5900JL MPU—16-Bit	19.95

SHIFT REGISTERS

MM500H Dual 5-Bit Dynamic	.50
MM500H Dual 10-Bit Dynamic	.50
MM500H Dual 100-Bit Static	.50
MM500H Dual 64-Bit Accumulator	.50
MM500H Dual 256-Bit	.50
MM501 1024-Bit Dynamic/Accumulator	1.95
MM501H 50512-Bit Dynamic	.85
MM503N Octal 80-Bit	9.95
MM503N Octal 80-Bit	9.95
504V (104A) 1024-Bit Dynamic	3.95
218N Hex 32-Bit Static	4.95
252V Dual 132-Bit Static	2.95
262V 512-Bit Dynamic	2.95
250V 1024-Bit Dynamic	3.95
252V Dual 256-Bit Static	2.95
258V Dual 260-Bit Static	4.00
250V Dual 260-Bit Static	4.00
252N Quad 80-Bit Static	2.95
3141PC FIFO (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN Universal Active Filter 2.5%	5.95
AF121-1CN Touch Tone Low Pass Filter	19.95
AF122-1CN Touch Tone Low Pass Filter	19.95
LM33AH Super Gain Amp	1.00
LM33Z Constant Current Source	1.00
LM132 Temperature Transducer	1.00
LF15N JFET Input Amp	1.15
LF39N Sample & Hold Amplifier	3.95
LF39HN Temp. Comp. Prec. Ref. (50ppm/C)	4.95
AD620BLCN 8-Bit A/D Converter (1.5%)	4.95
DAC0801CN 8-Bit D/A Converter (0.5% Lin.)	2.95

DATA ACQUISITION (CONTINUED)

AD0801CN 8-Bit A/D Converter (0.5% Multi.)	5.95
AD0801CN 8-Bit A/D Converter (0.5% Multi.)	10.95
DAC0801CN 10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC0801CN 10-Bit D/A Conv. Micro. Comp. (0.2%)	8.95
DAC0801CN 10-Bit D/A Converter (0.05% Lin.)	5.95
DAC0801CN 10-Bit D/A Converter (0.2% Lin.)	9.95
CD4051N 8-Channel Multiplexer	1.19
AY-5101 30K BAUD UART	5.95
1101 256K Static	1.49
1103 1024K Dynamic	.99
2101 (810) 256K Static	3.95
2102 1024K Static	1.95
2111 (811) 256K Static	3.95
2112 1024K Static	1.95
2113 1024K Static	3.95
2114 1024K Static 450ns	4.95
2114L 1024K Static 500ns Low Power	4.95
2114-3 1024K Static 500ns Low Power	5.95
2114-3L 1024K Static 500ns Low Power	4.95
4115 (UPD416) 64K Dynamic 250ns	3.95
4161 64K Dynamic 250ns	4.95
MM5214 4096K Fast 70ns	19.95
5101 256K Static	7.95
MM5261 1024K Dynamic Fully Decoded	.99
MM5262 2Kx1 Dynamic	.75
MM5262/2167 4096K Dynamic	4.95
MM5262/2167 8K Dynamic 150ns	5.95
MM5262/2167 16K Dynamic (lower % of MM5262)	4.95
UPD416/MK407 4K Dynamic 15-pin	14.95
TM5404-48NL 4K Static	14.95
TM5405 8K PROM	14.95

PROMS/EPROMS

1702A 2K V Erasable PROM	5.95
2708 8K EPROM	5.95
TM52716 16K EPROM (+5V, +5V, +12V)	19.95
2716Intel (2516)T 16K EPROM (Single +5V)	10.95
7221Intel (2521)T 16K EPROM (Single +5V)	19.95
2716 16K EPROM (60ns) (Single +5V)	7.95
5203 2048 PROM	14.95
62512 (2416) 32K EPROM (Open Collector)	4.95
62515 4096 Bipolar PROM	19.95
62512 (2416) 32K Tri-State Bipolar PROM	29.95
8K PROM	29.95

ROM'S

2131201 Character Generator (Upper Case)	9.95
2131201 Character Generator (Lower Case)	9.95
2131201 Character Generator	10.95
MM5230N 2048-Bit Read Only Memory	1.95

NMOS READ ONLY MEMORIES

MCN66710P 128x7 ASCII Shifted w/Greek	13.50
MCN66710P 128x7 Math Symbol & Pictures	13.50
MCN66710P 128x7 Alpha Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-280 User Manual	7.50
MC18012 User Manual	7.50
N-260 User Manual	5.00

SPECIAL FUNCTION

DS0025CN Dual MOS Clock Driver (SMZ)	3.50
DS0025CN Dual MOS Clock Driver (SMZ)	1.95
IN5171N-1 Happy Disc Controller	24.95
IN5261N Communication Chip	18.95
MM5167N Microprocessor Real Time Clock	8.95
MM5114N Microprocessor Compatible Clock	1.95
CPA022N Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
CPA022N Microcontroller with 64-Digit RAM and Direct LED Drive w/N Bus Int.	7.49
COR10N 32Kx8 VAC Fluid. Driver (20-pin pkg.)	3.25

TELEPHONE KEYBOARD CHIPS

AY-54100 Push Button Telephone Dialer	14.95
AY-54100 Rotary Dialer	14.95
AY-54100 CMOS Clock Generator	4.95
AY-54100 Keyboard Encoder (8 keys)	7.95
AY-54100 Keyboard Encoder (16 keys)	7.95
AY-54100 Keyboard Encoder (20 keys)	7.95
AY-54100 Push Button Pulse Dialer	7.95
AY-54100 16-Key Serial Keyboard Encoder	8.95

to the panel. The panels are then fastened to $\frac{3}{4}$ " thick traps inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.

MABUCHI RE280 \$.99 each . . . 10/\$7.50 . . . 100/\$50.00

DESIGNERS' SERIES

Blank Desk-Top Electronic Enclosures

Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	\$29.95
DTE-11	10.65"	\$32.95
DTE-14	14.00"	\$34.95

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to 3/4" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.

\$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus \$1 Insurance

Jameco ELECTRONICS
PHONE ORDERS WELCOME
(415) 592-8097

MAIL ORDER ELECTRONICS — WORLDWIDE
1355 SHOREWAY ROAD, BELMONT, CA 94002
PRICES SUBJECT TO CHANGE

Bourns Potentiometer

3/4 Watt Single Turn
(TOP ADJUSTMENT)

Values: 500Ω 1K 2.5K 5K 10K
25K 50K 100K 250K 500K 5Meg

INDIVIDUAL PRICING:
1-49 .19
50-99 .17
100-999 .15
1K-up .12

GB174 \$1.95/lot
(25 pieces all 11 asst. values)

To order: Specify Bourns 3355 — (Value desired)

AC and DC Wall Transformers

Ideal for use with clocks, games, power supplies or any other type of AC or DC application.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12 VAC 250mA	\$3.95
AC 500	117V/60Hz	12 VAC 500mA	\$4.95
AC1000	117V/60Hz	12 VAC 1 amp	\$5.95
AC2700	117V/60Hz	9 VAC 1.7 amp	\$6.95
DV 9200	117V/60Hz	9 VDC 200mA	\$3.25
DC 900	120V/60Hz	9 VDC 500mA	\$3.95

CONNECTORS

DB25P D-Subminiature Plug	\$2.95
DB25S D-Subminiature Socket	\$3.50
22/44SE Cover for DB25P/S	\$1.75
UG88/U P.C. Edge (22/44 Pin)	\$2.95
BNC Plug	\$1.79
BNC Jack	\$3.79
UG89/U UHF Adapter	\$.49
SO239 UHF Panel Recp.	\$1.29
PL258 UHF Adapter	\$1.60
PL259 UHF Plug	\$1.60
UG260/U BNC Plug	\$1.79
UG1094/U BNC Bulkhead Recp.	\$1.29

TRS-80

16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (N'S)
★ Documentation for Conversion

TRS-16K2 * 150NS \$39.95
TRS-16K4 * 250NS \$29.95

GLOBAL SPECIALTIES

EXPERIMENTOR SOCKETS

Model	Length	Width	Center Channel	5 Tie Point Terminals	Bus Strips	Price
EXP48	6.0"	1.0"	n/a	n/a	4(160)	\$ 4.75
EXP300	6.0"	2.1"	3"	94(470)	2(80)	\$12.00
EXP325	1.8"	2.1"	3"	22(110)	2(20)	\$ 3.50
EXP350	3.6"	2.1"	3"	46(230)	2(40)	\$ 6.75
EXP600	6.0"	2.4"	6"	94(470)	2(80)	\$14.75
EXP650	3.6"	2.4"	6"	46(230)	2(40)	\$ 8.75

Quick Test Sockets & Bus Strips

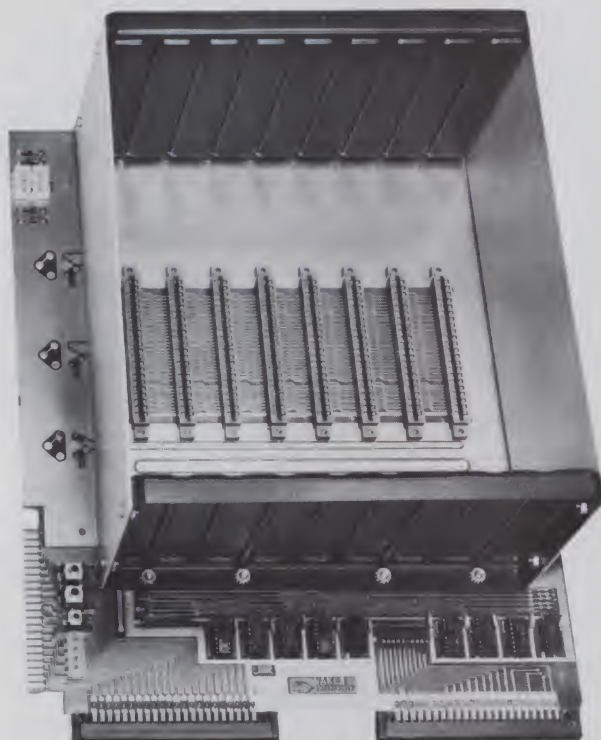
Length	Hole to Hole	Terminals	Unit Price \$
QT-595 6.5"	6.2"	118	\$12.25
QT-598 6.5"	6.2"	20	\$ 2.75
QT-475 5.3"	5.0"	94	\$ 9.75
QT-478 5.3"	5.0"	16	\$ 2.50
QT-355 4.1"	3.8"	70	\$ 7.25
QT-358 4.1"	3.8"	12	\$ 2.20
QT-185 2.4"	2.1"	36	\$ 4.50
QT-125 1.8"	1.5"	24	\$ 3.75
QT-85 1.4"	1.1"	16	\$ 3.00
QT-75 1.3"	1.0"	14	\$ 2.75

MANY OTHER GLOBAL ITEMS

See List of Advertisers on page 210

Microcomputing, June 1981 199

VAK-1 MOTHERBOARD



We also carry:

SYM-1	\$229 ⁰⁰
AIM-65 w/1K	389 ⁰⁰
AIM-65 w/4K	439 ⁰⁰

We also do custom hardware and software for the 6502 microprocessor

PRICE: \$139⁰⁰

Call or write for shipping charges and our complete catalog.

The VAK-1 was specifically designed for use with the KIM-1, SYM-1 and the AIM 65 Microcomputer Systems. The VAK-1 uses the KIM-4* Bus Structure, because it is the only popular Multi-Sourced bus whose expansion boards were designed specifically for the 6502 Microprocessor.

SPECIFICATIONS:

- Complete with rigid CARD-CAGE
- Assembled (except for card-cage). Burned in and tested.
- All IC's are in sockets
- Fully buffered address and data bus
- Uses the KIM-4* Bus (both electrical Pin-out and card size) for expansion board slots
- Provides 8 slots for expansion boards on 1" centers to allow for wire-wrap boards
- Designed for use with a Regulated Power Supply (such as our VAK-EPS) but has provisions for adding regulators for use with an unregulated power supply.
- Provides separate jacks for one audio-cassette, TTY and Power Supply.
- Board size: 14.5 in. Long x 11.5 in. Wide x 8 in. High
- Power requirements; 5V.DC @ 0.2 Amps.

**KIM-4 is a product of MOS Technology/C.B.M.*

 **ENTERPRISES**
INCORPORATED ✓52

2951 W. Fairmount Avenue
Phoenix, AZ 85017
(602) 265-7564



16K MEMORY — \$24.00

FOR APPLE - TRS-80 - EXIDY - S100

4116 EQUIVALENT

2114-300ns

NATIONAL MM5290N-3200ns 8 for \$ 24.00

NATIONAL MM2114N-3L8 for \$ 26.00



IMSAI COMPATIBLE PRODUCTS



I-8080 S-100 ENCLOSURE Sheet Metal Kit

Just like THE ORIGINAL IMSAI: Mainframe with blue cover, cardguides and hardware spaced for PS-28D Power Supply, up to 22 slot motherboard.

Kit of all metal parts and hardware with documentation \$115.00

Thinker Toys WunderBuss 20 for above w/o conn. \$ 79.00

AMPS-100 Connectors—each ... \$ 3.50

8015 Blank jump-start panel w/3 switches \$ 32.50

8035 Jump start panel for 2 SA-400\$ 78.50

PS-28D Power Supply Parts Kit:

Mounts in the I-8080 enclosure, supplies +8V @ 28A, +1 - 16V @ 3A, kit includes board, transformer, documentation, and all components. Improved from original.

Kit \$ 95.50

PIO 4-4

4 parallel inputs and outputs (8212) ... \$160.00

SIO 2-2

2 serial I/O ports, good to 19,200 baud . \$175.00

DIO-C/D

CPM® 2.2

CPA

2 board disk controller for 8" or 5 1/4" .. \$350.00

For DIO including documentation ... \$175.00

Improved Imsai style front panel works with Z80, etc. \$225.00

8080 processor board—requires CPA . \$100.00

8085 3MHz processor SBC w/serial plus parallel port, monitor \$250.00

64K byte dynamic RAM board—Utilizes the Intel 3242 refresh controller and a single delay line for totally internal refresh. Uses time proven 4116 RAMS. Memory mapped I/O boards are allowed to coexist by the use of A16 buss pin 16.

Assembled & Tested \$350.00

Bare Board w/docs \$ 40.00

Intelligent keyboard uses 8035 \$149.50

Dual SA400 drive enclosure \$ 75.00

Dual 800R/801R horizontal style enclosure w/power supply and fan \$240.00

Case Only..... \$100.00

MPU-A

MPU-B

RAM III 64K MEMORY

IKB-1

MDX

DE 8

COMPLETE SYSTEMS

I-8080 SYSTEM

The basic 8080 based S-100 system. Includes CPA front panel, 22 slot motherboard (with all 22 connectors), MPU-A 8080 CPU board, PS-28D power supply (+8V @ 28A, +1 - 16V @ 3A), and chassis. COMPLETELY ASSEMBLED & TESTED.

With MPU-A \$650.00

Without MPU-A \$600.00

Thinker Toys 10MHz WunderBuss add \$ 75.00

I-8015 Complete System w/MPU-B

The complete 8085 system, includes MPU-B, RAM III, 10 slot terminated motherboard, PS-28D, and jump start front panel. A complete 64K system!

Assembled & Tested \$1250.00

I-8035

The complete 8085 system w/2 each TANDON TM-100, DIO-D, MPU-B, RAM III, chassis, 10 slot motherboard and power supply. Includes CPM® 2.2.

Assembled & Tested \$2295.00

VDP-40

Desk-top 8085 micro-computer system with keyboard, 9" CRT display, 10 slot S-100 board, disk controller, 64K dynamic RAM, 2 each TANDON 5 1/4" disk drives, 28 amp power supply.

Assembled & Tested \$2895.00

DS-8

Dual 801R horizontal style 8" disk enclosure w/power supply, fan, and 2 Shugart 801R drives.

Assembled & Tested \$1100.00

Above w/DIO-C & CPM 2.2 \$1500.00

Ask about documentation, repair service, firmware and software for your system.



1771 Junction Avenue
San Jose, California 95112
(408) 295-7171

285

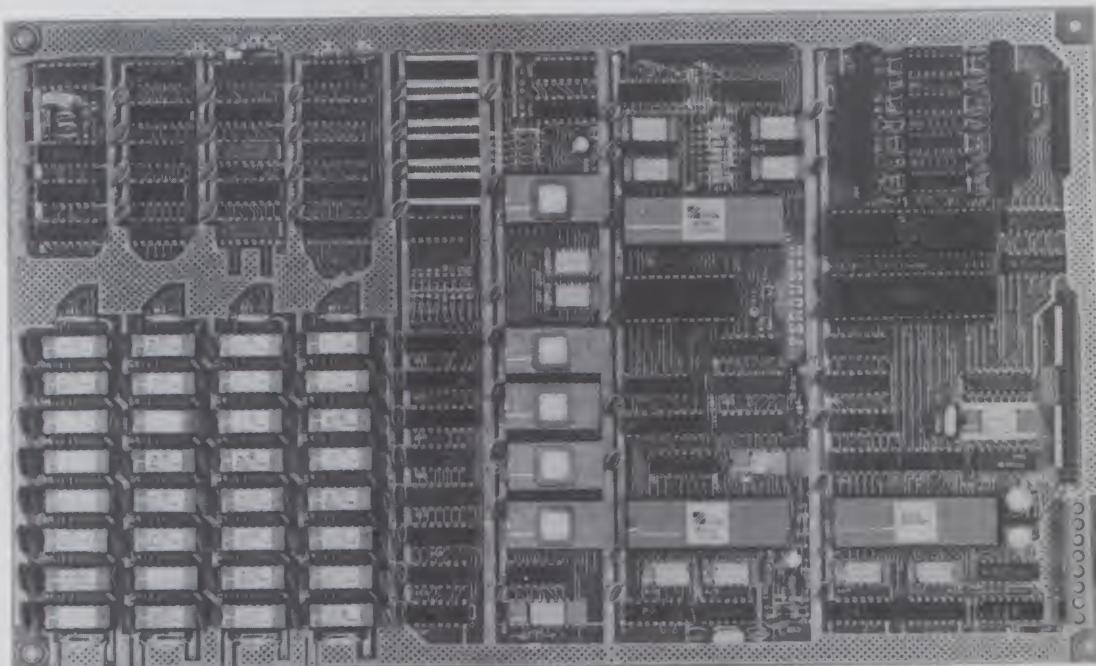
TERMS: (1) PREPAID Send check or M.O. for merchandise amount only - we pay the shipping within U.S. only.
(2) UPS COD or Bankcard orders by phone or mail - shipping charges added.
California Residents add 6.5% Sales Tax.

NEW!

"THE BIG BOARD" OEM - INDUSTRIAL - BUSINESS - SCIENTIFIC SINGLE BOARD COMPUTER KIT! Z-80 CPU! 64K RAM!

NEW!

PARTIALLY ASSEMBLED KITS
For All Sockets Installed
And Soldered Add \$50.



THE FERGUSON PROJECT: Three years in the works, and maybe too good to be true. A tribute to hard headed, no compromise, high performance, American engineering! The Big Board gives you all the most needed computing features on one board at a very reasonable cost. The Big Board was designed from scratch to run the latest version of CP/M*. Just imagine all the off-the-shelf software that can be run on the Big Board without any modifications needed! Take a Big Board, add a couple of 8 inch disc drives, power supply, an enclosure, C.R.T., and you have a total Business System for about 1/3 the cost you might expect to pay.

\$649⁰⁰ **

(64K KIT
BASIC I/O)

SIZE: 8 1/2 x 13 3/4 IN.
SAME AS AN 8 IN. DRIVE.
REQUIRES: +5V @ 3 AMPS
+ - 12V @ .5 AMPS.

FULLY SOCKETED!

FEATURES: (Remember, all this on one board!)

64K RAM

Uses industry standard 4116 RAM'S. All 64K is available to the user, our VIDEO and EPROM sections do not make holes in system RAM. Also, very special care was taken in the RAM array PC layout to eliminate potential noise and glitches.

Z-80 CPU

Running at 2.5 MHZ. Handles all 4116 RAM refresh and supports Mode 2 INTERRUPTS. Fully buffered and runs 8080 software.

SERIAL I/O (OPTIONAL)

Full 2 channels using the Z80 SIO and the SMC 8116 Baud Rate Generator. FULL RS232. For synchronous or asynchronous communication. In synchronous mode, the clocks can be transmitted or received by a modem. Both channels can be set up for either data-communication or data-terminals. Supports mode 2 Int. Price for all parts and connectors: \$85.

BASIC I/O

Consists of a separate parallel port (Z80 PIO) for use with an ASCII encoded keyboard for input. Output would be on the 80 x 24 Video Display.

24 x 80 CHARACTER VIDEO

With a crisp, flicker-free display that looks extremely sharp even on small monitors. Hardware scroll and full cursor control. Composite video or split video and sync. Character set is supplied on a 2716 style ROM, making customized fonts easy. Sync pulses can be any desired length or polarity. Video may be inverted or true. 5 x 7 Matrix - Upper & Lower Case

FLOPPY DISC CONTROLLER

Uses WD1771 controller chip with a TTL Data Separator for enhanced reliability. IBM 3740 compatible. Supports up to four 8 inch disc drives. Directly compatible with standard Shugart drives such as the SA800 or SA801. Drives can be configured for remote AC off-on. Runs CP/M* 2.2.

TWO PORT PARALLEL I/O (OPTIONAL)

Uses Z-80 PIO. Full 16 bits, fully buffered, bi-directional. User selectable hand shake polarity. Set of all parts and connectors for parallel I/O: \$29.95

REAL TIME CLOCK (OPTIONAL)

Uses Z-80 CTC. Can be configured as a Counter on Real Time Clock. Set of all parts: \$14.95

SYSTEM COMPARISON

64K RAM KIT	\$370.00
80 x 24 Video Kit	365.00
Floppy Disk Controller Kit	235.00
Z-80 CPU Kit	185.95
SER & PAR. I/O	129.95
S-100 Mother Board	45.00
SUB TOTAL	\$1330.90

Talk about bangs per buck! The prices shown for \$100 kits were taken from the July 1980 BYTE. This will give some basis for comparison between the Big Board and a similar system implementation on the S100 Buss.

CP/M* 2.2 FOR BIG BOARD

The popular CP/M* D.O.S. modified by MICRONIX SYSTEMS to run on Big Board is available for \$150.00.

PC BOARD

Blank PC Board with Rom Set and Full Documentation.
\$199.00

PFM 3.0 2K SYSTEM MONITOR

The real power of the Big Board lies in its PFM 3.0 on board monitor. PFM commands include: Dump Memory, Boot CP/M*, Copy, Examine, Fill Memory, Test Memory, Go To, Read and Write I/O Ports, Disc Read (Drive, Track, Sector), and Search. PFM occupies one of the four 2716 EPROM locations provided. Z-80 is a Trademark of Zilog.

Digital Research Computers
(OF TEXAS)

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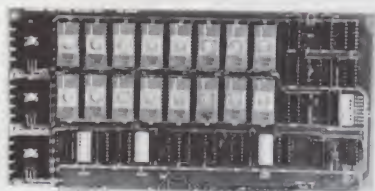
TERMS: Shipments will be made approximately 3 to 6 weeks after we receive your order. VISA, MC, cash accepted. We will accept COD's (for the Big Board only) with a \$75 deposit. Balance UPS COD. Add \$3.00 shipping

*TRADEMARK OF DIGITAL RESEARCH. NOT ASSOCIATED WITH DIGITAL RESEARCH OF CALIFORNIA, THE ORIGINATORS OF CPM SOFTWARE
**1 TO 4 PIECE DOMESTIC USA PRICE.

DIGITAL RESEARCH COMPUTERS

(214) 271-3538

32K S-100 EPROM CARD NEW!



\$79.95
KIT

USES 2716's
Blank PC Board - \$34
ASSEMBLED & TESTED
ADD \$30

SPECIAL: 2716 EPROM's (450 NS) Are \$9.95 Ea. With Above Kit.

KIT FEATURES:

1. Uses +5V only 2716 (2Kx8) EPROM's.
2. Allows up to 32K of software on line!
3. IEEE S-100 Compatible.
4. Addressable as two independent 16K blocks.
5. Cromemco extended or Northstar bank select.
6. On board wait state circuitry if needed.
7. Any or all EPROM locations can be disabled.
8. Double sided PC board, solder-masked, silk-screened.
9. Gold plated contact fingers.
10. Unselected EPROM's automatically powered down for low power.
11. Fully buffered and bypassed.
12. Easy and quick to assemble.

32K SS-50 RAM

\$329⁰⁰ KIT

For 2MHZ
Add \$10

Blank PC Board
\$50

For SWTPC
6800 - 6809 Buss

Support IC's
and Caps
\$19.95

Complete Socket Set
\$21.00

Fully Assembled,
Tested, Burned In
Add \$30

NEW!

At Last! An affordable 32K Static RAM with full 6809 Capability.

FEATURES:

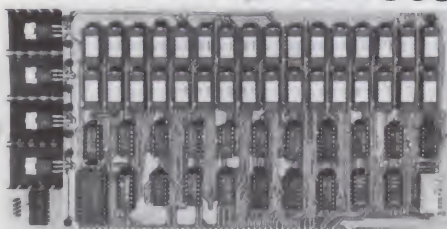
1. Uses proven low power 2114 Static RAMS.
2. Supports SS50C - EXTENDED ADDRESSING.
3. All parts and sockets included.
4. Dip Switch address select as a 32K block.
5. Extended addressing can be disabled.
6. Works with all existing 6800 SS50 systems.
7. Fully bypassed. PC Board is double sided, plated thru, with silk screen.

16K STATIC RAM KIT-S 100 BUSS

PRICE CUT!

\$169⁹⁵ KIT

FOR 4MHZ
ADD \$10



KIT FEATURES:

1. Addressable as four separate 4K Blocks.
2. ON BOARD BANK SELECT circuitry. (Cromemco Standard!) Allows up to 512K on line!
3. Uses 2114 (450NS) 4K Static Rams.
4. ON BOARD SELECTABLE WAIT STATES.
5. Double sided PC Board, with solder mask and silk screened layout. Gold plated contact fingers.
6. All address and data lines fully buffered.
7. Kit includes ALL parts and sockets.
8. PHANTOM is jumpered to PIN 67.
9. LOW POWER: under 1.5 amps TYPICAL from the +8 Volt Buss.
10. Blank PC Board can be populated as any multiple of 4K.

BLANK PC BOARD W/DATA-\$33
LOW PROFILE SOCKET SET-\$12
SUPPORT IC'S & CAPS-\$19.95
ASSEMBLED & TESTED-ADD \$35

**OUR #1 SELLING
RAM BOARD!**

16K STATIC RAM SS-50 BUSS

PRICE CUT!

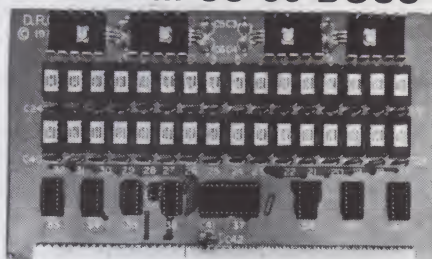
\$159 KIT

FULLY STATIC!

FOR 2MHZ
ADD \$10

FOR SWTPC
6800 BUSS!

ASSEMBLED AND
TESTED - \$35



KIT FEATURES:

1. Addressable on 16K Boundaries
2. Uses 2114 Static Ram
3. Fully Bypassed
4. Double sided PC Board Solder mask and silk screened layout
5. All Parts and Sockets included
6. Low Power: Under 1.5 Amps Typical

BLANK PC BOARD-\$35 COMPLETE SOCKET SET-\$12
SUPPORT IC'S AND CAPS-\$19.95

NEW! STEREO! S-100 SOUND COMPUTER BOARD NEW!

At last, an S-100 Board that unleashes the full power of two unbelievable General Instruments AY3-8910 NMOS computer sound IC's. Allows you under total computer control to generate an infinite number of special sound effects for games or any other program. Sounds can be called in BASIC, ASSEMBLY LANGUAGE, etc.

KIT FEATURES:

- * TWO GI SOUND COMPUTER IC'S
- * FOUR PARALLEL I/O PORTS ON BOARD
- * USES ON BOARD AUDIO AMPS OR YOUR STEREO.
- * ON BOARD PROTO TYPING AREA.
- * ALL SOCKETS, PARTS AND HARDWARE ARE INCLUDED
- * PC BOARD IS SOLDERMASKED, SILK SCREENED, WITH GOLD CONTACTS
- * EASY, QUICK, AND FUN TO BUILD. WITH FULL INSTRUCTIONS.
- * USES PROGRAMMED I/O FOR MAXIMUM SYSTEM FLEXIBILITY.

Both Basic and Assembly Language Programming examples are included.

SOFTWARE:

SCL™ is now available! Our Sound Command Language makes writing Sound Effects programs a SNAP! SCL™ also includes routines for Register-Examine-Modify, Memory-Examine-Modify, and Play-Memory. SCL™ is available on CP/M™ compatible diskette or 2708 or 2716. Diskette - \$24.95 2708 - \$19.95 2716 - \$29.95. Diskette includes the source. EPROM'S are ORG at E000H.

4K STATIC RAM

National Semi. MM5257. Arranged 4K x 1. +5V, 18 PIN DIP. A Lower Power, Plug in Replacement for TMS 4044. 450 NS. Several Boards on the Market Will Accept These Rams. SUPER SURPLUS PURCHASE! PRIME NEW UNITS!

8 FOR \$16 32 FOR \$59.95

COMPLETE KIT!

\$84⁹⁵

(WITH DATA MANUAL)

BLANK PC
BOARD W/DATA
\$31

4K DYNAMIC RAM BLOWOUT! SAME AS INTEL 2107B!

4K RAMS AT AN UNBELIEVABLE 50¢ EACH!!!

Prime, new, National Semi., 1979 date coded, full spec. parts. N.S. #MM5280-5N. Same as INTEL 2107B-4. T.I. TMS4060, NEC uPD411, etc. We bought a HUGE QTY. from a West Coast Distributor at truly DISTRESS PRICES! One of the most popular and reliable RAM's ever made. These parts have been used by almost all Major Computer Main Frame Mfg. the world over! Arranged as 4K x 1, 270 NS Access Time, 22 Pin Dip. These units DO NOT use multiplexed addressing, thus making REFRESH and other timing very simple. See INTEL MEMORY DESIGN HANDBOOK for full application notes. The NAT. SEMI. MEMORY DATA BOOK is available at most Radio Shack Stores. Prime units in original factory tubes!

#5280-5N 4096 BITS x 1 270 NS ACCESS

8 FOR \$4.95 32 FOR \$16

CRT CONTROLLER CHIP

SMC #CRT 5037. PROGRAMMABLE FOR 80 x 24, ETC. VERY RARE SURPLUS FIND. WITH PIN OUT. \$12.95 EACH.

NEW! G.I. COMPUTER SOUND CHIP

AY3-8910. As featured in July, 1979 BYTE! A fantastically powerful Sound & Music Generator. Perfect for use with any 8 Bit Microprocessor. Contains 3 Tone Channels, Noise Generator, 3 Channels of Amplitude Control. 16 bit Envelope Period Control, 2-8 Bit Parallel I/O. 3 D to A Converters, plus much more! All in one 40 Pin DIP. Super easy interface to the S-100 or other busses. \$11.95 PRICE CUT!

SPECIAL OFFER: \$14.95 each Add \$3 for 60 page Data Manual.

TERMS: Add \$2.00 postage. We pay balance. Orders under \$15 add 75¢ handling. No C.O.D. We accept Visa and MasterCard. Tex. Res. add 5% Tax. Foreign orders (except Canada) add 20% P & H. Orders over \$50, add 85¢ for insurance.

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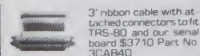
ALL GOODS ARE MADE SUBJECT TO THE TERMS OF OUR 30 DAY LIMITED WARRANTY. A COPY OF THIS WARRANTY IS AVAILABLE FREE, ON REQUEST.

TRS-80 SERIAL I/O

- Can input into basic
- Can use LLIST and LPRINT to output, or output continuously
- RS-232 compatible
- Can be used with or without the expansion bus
- On board switch selectable baud rates of 110, 150, 300, 600, 1200, 2400, parity or no parity odd or even, 5 to 8 data bits, and 1 or 2 stop bits. D.T.R. line
- Requires +5, -12 VDC
- Board only \$19.95 Part No. 8010, with parts \$76.69 Part No. 8010A, assembled \$98.25 Part No. 8010 C. No connectors provided, see below.



EIA/RS-232 connector Part No. DB25P \$6.00, with 9 ft ductor cable \$19.65 Part No. DB25P9



VIDEO TERMINAL



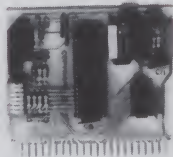
16 lines, 64 columns • Upper and lower case • 5x7 dot matrix • Serial RS-232 in and out with TTL parallel keyboard input • On board baud rate generator 75, 110, 150, 300, 600, & 1200 jumper selectable • Memory 1024 characters (7-21L02) • Video processor chip SFF96364 by Neculonic • Control characters (CR, LF, →, ←, ↑, ↓, non destructive cursor, CS, home, CL) • White characters on black background or vice-versa • With the addition of a keyboard, video monitor or TV set with TV interface (part no. 107A) and power supply this is a complete stand alone terminal • also S-100 compatible • requires +16, & -16 VDC at 100mA, and 8VDC at 1A. Part No. 1000A \$296.45 kit.

GAME PADDLES & SOUND FOR TRS-80



Includes: 2 game paddles, interface, software, speaker, power supply, full documentation including: schematics, theory of operation, and user guide; plus 2 games on cassette, Pong and Starship War \$157.29 Complete Part No. 7922C

SERIAL/ PARALLEL INTERFACE



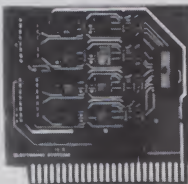
- Converts serial to parallel and parallel to serial
- Low cost on board baud rate generator
- 110 to 19.2K
- Low power drain +5 volts and -12 volts required
- TTL compatible
- All characters contain a start bit, 5 to 8 data bits, 1 or 2 stop bits, and either odd or even parity
- All connections go to a 44 pin gold plated edge connector
- Board only \$11.95 Part No. 101, with parts \$42.89 Part No. 101A, 44 pin edge connector \$4.00 Part No. 44P

MODEM



- Type 103
- Full or half duplex
- Works up to 300 baud
- Originate or Answer
- Serial TTL input and output
- connect 8 Ω speaker and crystal mic. directly to board
- Requires +5 volts
- Board only \$7.60
- Part No. 109, with parts \$29.95 Part No. 109A.

OPTO-ISOLATED PARALLEL INPUT BOARD FOR APPLE II



Part No. 120, with parts \$69.95. Part No. 120A.

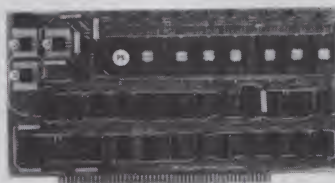
There are 8 inputs that can be driven from TTL logic or any 5 volt source. The circuit board can be plugged into any of the 8 sockets of your Apple II. It has a 16 pin socket for standard dip ribbon cable connection. Board only \$15.65

SUPER MODEM



Originate, RS-232 and 20mA compatible. Full duplex, and half duplex, direct connect or acoustic coupled, on board power supply, carrier detect light, DB25 plug, 300 BAUD, Type 103 compatible frequencies. Bare board Part No. 2000 \$21.89, Kit Part No. 2000A \$133.80

8K EPROM SAVER



- Programs 2708's address relocation of each 4K of memory to any 4K boundary
- Power on jump and reset jump option for "turnkey" systems and computers without a front panel
- Program saver software in 1 2708 EPROM \$25. Bare board \$45.59 including custom coil, board with parts but no EPROMS \$164.69.

APPLE II SERIAL I/O INTERFACE



Baud rate is continuously adjustable from 0 to 30,000 • Plugs into any peripheral connector • Low current drain. RS-232 input and output • On board switch selectable 5 to 8 data bits, 1 or 2 stop bits, and parity or no parity either odd or even • Jumper selectable address • SOFTWARE • Input and Output routine from monitor or BASIC to teletype or other serial printer • Program for using an Apple II for a video or an intelligent terminal. Also can output in correspondence code to interface with some electrics. • Also watches DTR • Board only \$14.95 Part No. 2, with parts \$51.25 Part No. 2A, assembled \$62.95 Part No. 2C

PARALLEL TRIAC OUTPUT BOARD FOR APPLE II



This board has 8 triacs capable of switching 110 volt 6 amp loads (660 watts per channel) or a total of 5280 watts. Board only \$15.65 Part No. 210, with parts \$119.95 Part No. 210A

APPLE II PROTOTYPING HOBBY/CARD

Part No. 7907
\$21.95

RS-232/20mA INTERFACE

This board has two passive, opto-isolated circuits. One converts RS-232 to 20mA, the other converts 20mA to RS-232. All connections go to a 10 pin edge connector. Requires +12 and -12 volts. Board only \$9.95, part no. 7901, with parts \$14.95 Part No. 7901A.

T.V. INTERFACE



- Converts video to AM modulated RF, Channels 2 or 3. So powerful almost no tuning is required. On board regulated power supply makes this extremely stable. Rated very highly in Doctor Dobbs' Journal. Recommended by Apple
- Power required is 12 volts AC C.T., or +5 volts DC
- Board only \$8.19 part No. 107, with parts \$18.85 Part No. 107A

S-100 BUS ACTIVE TERMINATOR



Board only \$18.15 Part No. 900, with parts \$29.89 Part No. 900A.

SERIAL I/O



Four Serial I/O RS-232 ports. S-100 Bus, Software or jumper selectable baud rate (110, 300, 600, 1200, 2400, 4800, 9600, 19.2K), on board Xtal baud rate generator, Addressing, switch selectable, Parity or no parity (odd or even) switch selectable, 1 or 2 stop bits, 5 to 8 bits/character. Board only \$35.19 Part No. 7908. With parts (kit) \$199.95, Part No. 7908A.

TAPE INTERFACE



- Converts a low cost tape recorder to a digital recorder
- Works up to 1200 baud
- Digital in and out are TTL serial
- Output of board connects to mic. in of recorder
- Earphone of recorder connects to input on board
- No coils
- Requires +5 volts, low power drain
- Board only \$7.60 Part No. 111, with parts \$29.95 Part No. 111A

RS-232/TTL INTERFACE



- Converts TTL to RS-232, and converts RS-232 to TTL
- Two separate circuits
- Requires -12 and +12 volts
- All connections go to a 10 pin edge connector; kit \$9.95 Part No. 232A 10 pin edge connector \$3.00 part No. 10P.

RS-232/TTY INTERFACE



This board has two active circuits, one converts RS-232 to 20 mA, the other converts 20 mA to RS-232. Requires +12 and -12 volts. \$9.95 Part No. 600A Kit.

Send for FREE Catalog...a big self addressed envelope with 80¢ postage gets it fastest!

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Mention part no., description, and price. In USA shipping paid by us for orders accompanied by check or money order. We accept C.O.D. orders (U.S. only) or a VISA or Master Charge no., expiration date, signature and phone no., shipping charges will be added. CA residents add 6.5% for tax. Outside USA add 15% for air mail postage and handling. Payment must be in U.S. dollars. Dealer inquiries invited. Prices subject to change without notice.

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ELECTRONIC SYSTEMS

Dept. KB, P.O. BOX 21638, San Jose, CA USA 95151

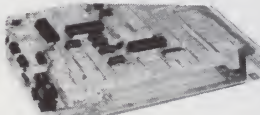
Start learning and computing for only **\$129.95** with a Netronics 8085-based computer kit. Then expand it in low-cost steps to a business/development system with 64k or more RAM, 8" floppy disk drives, hard disks and multi-terminal I/O.

THE NEW EXPLORER/85 SYSTEM

Special! Full 8" floppy, 64k system for less than the price of a mini! Only **\$1499.95!**

(Also available wired & tested, \$1799.95)

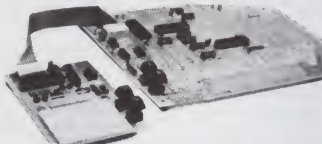
Imagine — for only \$129.95 you can own the starting level of Explorer/85, a computer that's expandable into full business/development capabilities — a computer that can be your beginner system, an OEM controller, or an IBM-formatted 8" disk small business system. From the first day you own Explorer/85, you begin computing on a significant level, and applying principles discussed in leading computer magazines. Explorer/85 features the advanced Intel 8085 cpu, which is 100% compatible with the older 8080A. It offers on-board S-100 bus expansion, Microsoft BASIC in ROM, plus instant conversion to mass storage disk memory with standard IBM-formatted 8" disks. All for only \$129.95, plus the cost of power supply, keyboard/terminal and RF modulator if you don't have them (see our remarkable prices below for these and other accessories). With a Hex Keypad/display front panel, Level "A" can be programmed with no need for a terminal, ideal for a controller, OEM, or a real low-cost start.



Level "A" is a complete operating system, perfect for beginners, hobbyists, industrial controller use. \$129.95



Full 8" disk system for less than the price of a mini (shown with Netronics Explorer/85 computer and new terminal). System features floppy drive from Control Data Corp., world's largest maker of memory storage systems (not a hobby brand!)



Level "A" With Hex Keypad/Display.

LEVEL "A" SPECIFICATIONS

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an advanced 8155 RAM I/O ... all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, plus generous prototyping space.

PC Board: Glass epoxy, plated through holes with solder mask. • I/O: Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ... cassette tape recorder input and output ... cassette tape control output ... LED output indicator on SOD (serial output) line ... printer interface (less drivers) ... total of four 8-bit plus one 6-bit I/O ports. • Crystal Frequency: 6.144 MHz. • Control Switches: Reset and user (RST 7.5) interrupt ... additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • Counter/Timer: Programmable, 14-bit binary. • System RAM: 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems. • RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F800, leaving 6000 free for user RAM/ROM. Features include tape load with labeling ... examine/change contents of memory ... insert data ... warm start ... examine and change all registers ... single step with register display at each break point, a debugging/training feature ... go to execution address ... move blocks of memory from one location to another ... fill blocks of memory with a constant ... display blocks of memory ... automatic baud rate selection to 9600 baud ... variable display line length control (1-255 characters/line) ... channelized I/O monitor routine with 8-bit parallel output for high-speed printer ... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Keypad/Display Version): Tape load with labeling ... tape dump with labeling ... examine/change contents of memory ... insert data ... warm start ... examine and change all registers ...

single step with register display at each break point ... go to execution address. Level "A" in this version makes a perfect controller for industrial applications, and is programmed using the Netronics Hex Keypad/Display. It is low cost, perfect for beginners.

HEX KEYPAD/DISPLAY SPECIFICATIONS

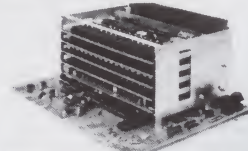
Calculator type keypad with 24 system-defined and 16 user-defined keys. Six digit calculator-type display, that displays full address plus data as well as register and status information.

LEVEL "B" SPECIFICATIONS

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards, and includes: address decoding for onboard 4k RAM expansion selectable in 4k blocks ... address decoding for onboard 8k EPROM expansion selectable in 8k blocks ... address and data bus drivers for onboard expansion ... wait state generator (jumper selectable), to allow the use of slower memories ... two separate 5 volt regulators.

LEVEL "C" SPECIFICATIONS

Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the origi-

nal 256 bytes located in the 8155A). The static RAM can be located anywhere from 8000 to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

DISK DRIVE SPECIFICATIONS

- 8" CONTROL DATA CORP professional drive.
- LSI controller.
- Write protect.
- Single or double density.
- Data capacity: 401,016 bytes (SD), 802,032 bytes (DD), unformatted.
- Access time: 25ms (one track).

DISK CONTROLLER/I/O BOARD SPECIFICATIONS

- Controls up to four 8" drives.
- 1771A LSI (SD) floppy disk controller.
- Onboard data separator (IBM compatible).
- 2 Serial I/O ports.
- Autoboot to disk system when system reset.
- 2716 PROM socket included for use in custom applications.
- Onboard crystal controlled.
- Onboard I/O baud rate generators to 9600 baud.
- Double-sided PC board (glass epoxy.)

DISK DRIVE CABINET/POWER SUPPLY

- Deluxe steel cabinet with individual power supply for maximum reliability and stability.

ORDER A COORDINATED EXPLORER/85 APPLICATIONS PAK!

Beginner's Pak (Save \$26.00!) — Buy Level "A" (Terminal Version) with Monitor Source Listing and AP-1 5-amp Power Supply: (regular price \$199.95), now at SPECIAL PRICE: **\$169.95** plus post. & insur.

Experimenter's Pak II (Save \$53.40!) — Buy Level "A" (Hex Keypad/Display Version) with Hex Keypad/Display, Intel 8085 User Manual, Level "A" Hex Monitor Source Listing, and AP-1 5-amp Power Supply: (regular price \$279.35), all at SPECIAL PRICE: **\$219.95** plus post. & insur.

Special Microsoft BASIC Pak (Save \$103.00!) — Includes Level "A" (Terminal Version), Level "D" (4k RAM), Level "E", 8k Microsoft in ROM, Intel 8085 User Manual, Level "A" Monitor Source Listing, and AP-1 5-amp Power Supply: (regular price \$439.70), now yours at SPECIAL PRICE: **\$329.95** plus post. & insur.

ADD A TERMINAL WITH CABINET, GET A FREE RF MODULATOR: Save over \$114 at this SPECIAL PRICE: **\$499.95** plus post. & insur.

Special 8" Disk Edition Explorer/85 (Save over \$104!) — Includes disk-version Level "A", Level "B", two S-100 connectors and brackets, disk controller, 64k RAM, AP-1 5-amp power supply, Explorer/85 deluxe steel cabinet, cabinet fan, 8" SD/DD disk drive from famous CONTROL DATA CORP. (not a hobby brand!), drive cabinet with power supply, and drive cable set-up for two drives. This package includes everything but terminal and printers (see coupon for them). Regular price \$1630.30, all yours in kit at SPECIAL PRICE: **\$1499.95** plus post. & insur. Wired and tested, only **\$1799.95**.

Special! Complete Business Software Pak (Save \$625.00!) — Includes CP/M 2.0, Microsoft BASIC, General Ledger, Accounts Receivable, Accounts Payable, Payroll Package: (regular price \$1325), yours now at SPECIAL PRICE: **\$699.95**.

Please send the items checked below:

- ☐ Explorer/85 Level "A" kit (Terminal Version) ... \$129.95 plus \$3 post. & insur.
- ☐ Explorer/85 Level "A" kit (Hex Keypad/Display Version) ... \$129.95 plus \$3 post. & insur.
- ☐ 8k Microsoft BASIC on cassette tape, \$64.95 postpaid.
- ☐ 8k Microsoft BASIC in ROM kit (requires Levels "B", "D" and "E") ... \$99.95 plus \$2 post. & insur.
- ☐ Level "B" (S-100) kit ... \$49.95 plus \$2 post. & insur.
- ☐ Level "C" (S-100 6-card expander) kit ... \$39.95 plus \$2 post. & insur.
- ☐ Level "D" (4k RAM) kit ... \$69.95 plus \$2 post. & insur.
- ☐ Level "E" (EPROM/ROM) kit ... \$3.95 plus \$0.50 p&h.
- ☐ Deluxe Steel Cabinet for Explorer/85 ... \$49.95 plus \$3 post. & insur.
- ☐ Fan For Cabinet ... \$15.00 plus \$1.50 post. & insur.
- ☐ ASCII Keyboard/Computer Terminal kit: features a full 128 character set, u&l case; full cursor control; 75 ohm video output; convertible to baudot output, selectable baud rate, RS232-C or 20 ma. I/O. 32 or 64 character by 16 line formats, and can be used with either a CRT monitor or a TV set (if you have an RF modulator) ... \$149.95 plus \$3.00 post. & insur.
- ☐ De-Luxe Steel Cabinet for ASCII keyboard/terminal ... \$19.95 plus \$2.50 post. & insur.
- ☐ New Terminal/Monitor: (See photo) Same features as above, except 12" monitor with keyboard and terminal is in deluxe single cabinet kit ... \$399.95 plus \$7 post. & insur.
- ☐ Hazeltine terminals: Our prices too low to quote — CALL US
- ☐ Lear-Sigler terminals/printers: Our prices too low to quote, CALL US
- ☐ Hex Keypad/Display kit ... \$69.95 plus \$2 post. & insur.

- ☐ AP-1 Power Supply Kit ±8V @ 5 amps) in deluxe steel cabinet ... \$39.95 plus \$2 post. & insur.
- ☐ Gold Plated S-100 Bus Connectors ... \$4.85 each, postpaid.
- ☐ RF Modulator kit (allows you to use your TV set as a monitor) ... \$8.95 postpaid.
- ☐ 16k RAM kit (S-100 board expands to 64k) ... \$199.95 plus \$2 post. & insur.
- ☐ 32k RAM kit ... \$299.95 plus \$2 post. & insur.
- ☐ 48k RAM kit ... \$399.95 plus \$2 post. & insur.
- ☐ 64k RAM kit ... \$499.95 plus \$2 post. & insur.
- ☐ 16k RAM Expansion kit (to expand any of the above in 16k blocks up to 64k) ... \$99.95 plus \$2 post. & insur. each.
- ☐ Intel 8085 cpu Users' Manual ... \$7.50 postpaid.
- ☐ 12" Video Monitor (10MHz bandwidth) ... \$139.95 plus \$5 post. & insur.
- ☐ Beginner's Pak (see above) \$169.95 plus \$4 post. & insur.
- ☐ Experimenter's Pak (see above) ... \$219.95 plus \$6 post. & insur.
- ☐ Special Microsoft BASIC Pak Without Terminal (see above) ... \$329.95 plus \$7 post. & insur.
- ☐ Same as above, plus ASCII Keyboard Terminal With Cabinet, Get Free RF Modulator (see above) ... \$499.95 plus \$10 post. & insur.
- ☐ Special 8" Disk Edition Explorer/85 (see above) ... \$1499.95 plus \$26 post. & insur.
- ☐ Wired & Tested ... \$1799.95 plus \$26 post. & insur.
- ☐ Extra 8" CDC Floppy Drives ... \$499.95 plus \$12 post. & insur.
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- ☐ Disk Controller Board With I/O Ports ... \$199.95 plus \$2 post. & insur.
 - ☐ Special: Complete Business Software Pak (see above) ... \$699.95 postpaid.
- SOLD SEPARATELY:
- ☐ CP/M 1.4 ... \$100 postpaid.
 - ☐ CP/M 2.0 ... \$150 postpaid.
 - ☐ Microsoft BASIC ... \$325 postpaid.
 - ☐ Intel 8085 cpu User Manual ... \$7.50 postpaid.
 - ☐ Level "A" Monitor Source Listing ... \$25 postpaid.

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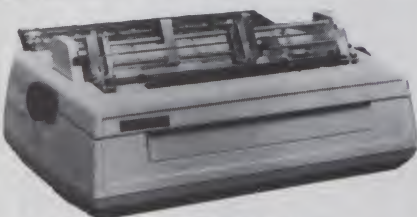
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Printers



MX-80 - Epson
132 column, 9 x 9 dot matrix, multiple fonts
PRM-27080 Save \$100.00 Call

MX-70
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Interface & Cable for Apple \$110.00



SPINWRITER - NEC
65 cps, bi-directional, letter quality printer with deluxe tractor mechanism, both parallel and serial interfaces on-board, 16K buffer, ribbon, print thimble, graphics, micro-space justification, data cable, and self test/diagnostic ROM.
PRD-55511 without 16K buffer ... \$2795.00
PRD-55512 with 16K buffer \$2895.00

Accessories for TRS-80



DISK DRIVES for TRS-80
23% more storage, 8 times faster, 40 track with free patch, 120 day warranty.
MSM-12410C Save \$125.00 !!! \$325.00

8" DISK DRIVES for MODEL II
2 double density drives with cabinet, power supply, & cables
END-000433 Kit \$1050.00
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Special Purchase - Save \$50.00
Novation Cat Modem
300 baud, answer and originate



(We have
only ~~200~~ 265
available at this
special price)

IOM-5200A List price \$189.95 \$139.95
D-CAT 300 baud, direct connect modem
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Accessories for Apple



16K MEMORY UPGRADE
Add 16K of RAM to your TRS-80, Apple, or Exidy in just minutes. We've sold thousands of these 16K RAM upgrades which include the appropriate memory chips (as specified by the manufacturer), all necessary jumper blocks, fool-proof instructions, and our 1 year guarantee.
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(There is life after 48K)
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The ultimate program for your Apple II
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Upgrade your old DOS to the improved 3.3
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5 1/4" disk drive with controller for your Apple
MSM-12310C with controller \$475.00
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8" DRIVES for APPLE
Controller, DOS, two 8" double density drives, cabinet, power supply, & cables
Special Package Price Kit \$1399.95

PRINTER INTERFACE - C.C.S.
Centronics type I/O card w/ firmware
I0I-2041A A & T \$99.95

AIO, ASIO, APIO - S.S.M.
Parallel & serial interface for your Apple (see Byte pg 11)
I0I-2050K Par & Ser kit \$129.95
I0I-2050A Par & Ser A & T \$159.95
I0I-2052K Serial kit \$89.95
I0I-2052A Serial A & T \$99.95
I0I-2054K Parallel kit \$69.95
I0I-2054A Parallel A & T \$89.95

A488 - S.S.M.
IEEE 488 controller, uses simple basic commands, includes firmware and cable, 1 year guarantee, (see April Byte pg 11)
I0X-7488A A & T \$399.95

Disk Drives

JADE's new dual disk sub-assemblies include: Handsome metal cabinet with proportionally balanced air flow system, assembled & tested dual drive power supply, quiet whisper type cooling fan, power-cable kit, lighted power switch, approved fuse assembly, line cord, Never-Mar rubber feet, and all necessary hardware to mount 2-8" disk drives - it's all American made, guaranteed for six months, and it's in stock!

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Single sided, double density disk drive sub-system
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Double sided, double density disk drive sub-system
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END-000427 A & T w/2 8" drives \$1695.00

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Highly reliable double density floppy disk drives
Shugart 801R single sided, double density
MSF-10801R SA-801R \$425.00
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MSF-201120 6 mo warranty \$385.00
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MSF-750080 SA-851R compatible .. \$599.95
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JADE DISK PACKAGE

Double density controller, two 8" double density floppy disk drives, CP/M 2.2 (configured for controller), hardware and software manuals, boot PROM, cabinet, power supply, fan, & cables
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5 1/4" single sided, single density, box of 10
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MMD-5111003 10 sector \$27.95
MMD-5111603 16 sector \$27.95
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MMD-5220103 Soft sector \$39.95
8" single sided, single density, box of 10
MMD-8110103 Soft sector \$33.95
8" single sided, double density, box of 10
MMD-8120103 Soft sector \$39.95
8" double sided, double density, box of 10
MMD-8220103 Soft sector \$49.95

Video Monitors

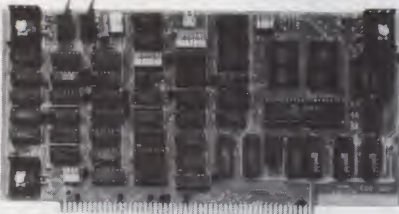
13" COLOR MONITOR - Zenith
The hi res color you've been promising yourself
VDC-201301 \$449.00

12" GREEN SCREEN - NEC
20 MHz, P31 phosphor video monitor with audio exceptionally high resolution - A fantastic monitor at a very reasonable price
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Leedex / Amdek
Reasonably priced video monitors
VDM-801210 Video 100 12" B&W .. \$149.99
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VDM-801250 12" Green Phosphor \$189.99
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Fast Service.

S-100 CPU



CB-2 Z-80 CPU - S.S.M.

2 or 4 MHz Z-80 CPU board with provision for up to 8K of ROM or 4K of RAM on board, extended addressing, IEEE S-100, front panel compatible.

CPU-30300K Kit \$239.95
CPU-30300A A & T \$299.95

THE BIG Z* - Jade

2 or 4 MHz switchable Z-80* CPU with serial I/O, accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600

CPU-30201K Kit \$145.00
CPU-30201A A & T \$199.00
CPU-30200B Bare board \$35.00

2810 Z-80* CPU - Cal Comp Sys

2/4 MHz Z-80A* CPU with RS-232C serial I/O port and on-board MOSS 2.2 monitor PROM, front panel compatible.

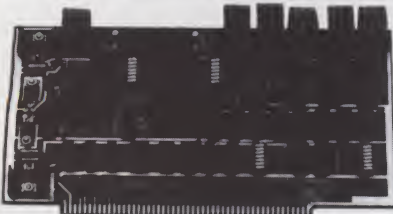
CPU-30400A A & T \$269.95

SBC-200 - SD Systems

4 MHz Z-80* CPU with serial & parallel I/O ports, up to 8K of on-board PROM, software programmable baud rate generator, 1K of on-board RAM, Z-80 CTC.

CPC-30200K Kit \$339.95
CPC-30200A Jade A & T \$399.95

S-100 I/O



I/O-4 - S.S.M.

2 serial I/O ports plus 2 parallel I/O ports

IOI-1010K Kit \$159.95
IOI-1010A A & T \$219.95
IOI-1010B Bare board \$35.00

S.P.I.C. - Jade

Our new I/O card with 2 SIO's, 4 CTC's, and 1 PIO

IOI-1045K 2 CTC's, 1 SIO, 1 PIO .. \$199.00
IOI-1045A A & T \$259.00
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IOI-1046A A & T \$319.00
IOI-1045B Bare board w/ manual ... \$59.95
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Motherboards

ISO-BUS - Jade

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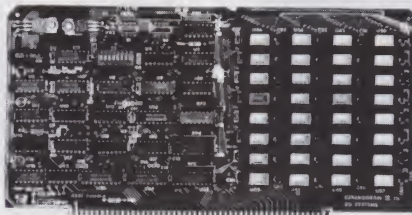
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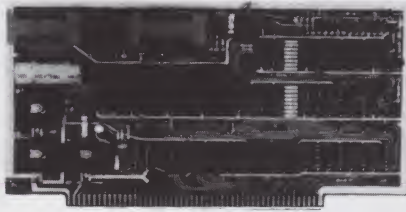
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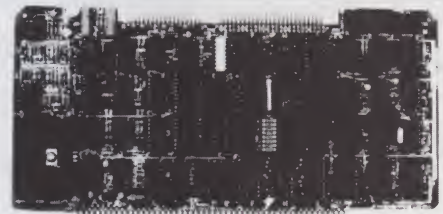
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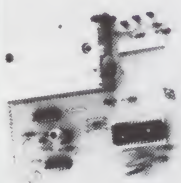
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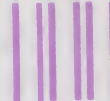
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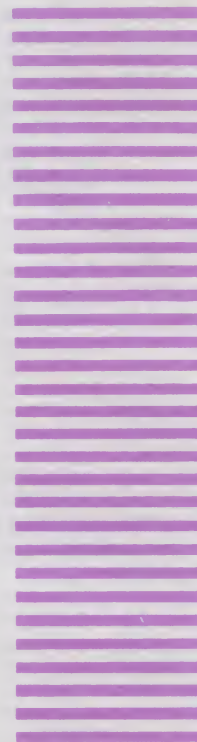
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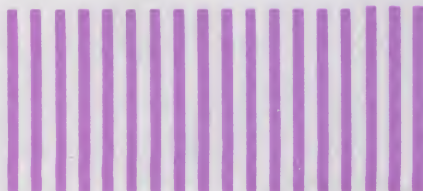
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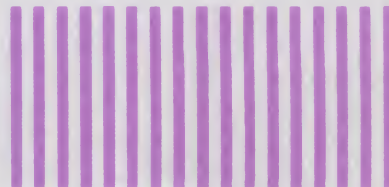
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LETTERS

(from page 30)

cution space, speed or efficiency. This sequence uses the assembler as the subtractor: load track number, add address of DDATA - 1 fetch from memory.

I have found that the preferred numbering scheme is usually clear from the application and the language facilities. What is probably most important is that the program comments and/or documentation makes it clear as to which scheme is used, and why.

Richard A. Holmes
Las Vegas, NV

Polyalgorithms

Bob Fruit's letter in the April issue (p. 29) concerning Arnold Bragg's "Area Estimation" prompts this one.

Bragg's algorithm is indeed simple, but not as simple as it could be. Listing 1 shows a BASIC rendering of an even simpler implementation. The basic idea is that the determinant of a matrix is the signed area of a certain parallelepiped. If, for example, the matrix is one whose first row is (2, -1) and second is (1, 1), then its determinant, 3, is the area of the parallelogram whose vertices are (0,0), (2, -1), (1, 1) and (3, 0) (= the sum of (2, -1) and (1, 1)). The ordering of the rows of the matrix determines the sign. Half this area is the area of the triangle with vertices (0,0), (2, -1) and (1, 1). Summing these signed areas over an appropriate sequence of vertex pairs gives the signed area of an arbitrary polygon (unwanted area cancelling out nicely).

One such polygon is the one Fruit mentions whose vertices are on a ring. Hence Bragg's algorithm still works in one pass

for such a figure. For a simple example consider the "square" ring whose vertices are (1,1), (1, -1), (-1, -1), (-1, 1), (2,2), (2, -2), (-2, -2) and (-2, 2). Use Bragg's algorithm traversing the points in the order (2,2), (2, -2), (-2, -2), (-2, 2), (2,2), (1,1), (-1, 1), (-1, -1), (1, -1), (1, 1), i.e., clockwise around the outside and counterclockwise around the inside.

William A. McWorter, Jr.
Ohio State University
Columbus, OH

H-89 Software

Your review of the H-89 ("Building the H-89," March-April 1981) mentions software availability as an area of concern. In this regard, your readers should know about The Software Toolworks.

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```
10 ' *** PROGRAM FOR THE SIGNED AREA OF A POLYGON ***
20 '
30 PRINT "ENTER VERTICES IN THE ORDER A BORDER GUARD WOULD TRAVERSE THEM"
40 PRINT "KEEPING THE INTERIOR OF THE POLYGON TO HIS RIGHT. THE ENTRY"
50 PRINT "SYNTAX IS X,Y.(2ND COMMA REQUIRED). SIGNAL THE END OF ENTRIES"
60 PRINT "BY ENTERING A THIRD NON-ZERO NUMBER WITH THE LAST ENTRY."
70 PRINT "(CHANGING THE ORDER AND/OR THE LAST ENTRY EXTENDS THE FLEXIBILITY"
80 PRINT "OF THIS PROGRAM TO COMPUTE INTEGRALS OF FUNCTIONS AND THEIR"
90 PRINT "ABSOLUTE VALUES)"
100 '
110 ' COMPUTE 2*AREA AS VERTICES ARE INPUT
120 '
130 INPUT X,Y,Z:A = A + X*T - S*Y:PRINTA/2:IFZ = 0 THEN S = X:T = Y:GOTO 130
140 '
150 ' PRINT RESULT
160 '
170 PRINT:PRINT "THE SIGNED AREA IS":A/2
180 '
190 ' RERUN THE PROGRAM
200 '
210 PRINT:A=0:S=0:T=0:Z=0:GOTO 130
```

Listing 1.

price range. Nonetheless, it works and works well.

**Walt Bilofsky, Prop.
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Any Interest?

We would like to hear from anyone interested in subscribing to a network of hobby computers in which the central system would place calls to all other users during the evening hours (reduced rates).

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We don't know if such a system will be feasible, but we would appreciate it if anyone interested in investigating the possibilities would send us any comments, questions or suggestions, along with a stamped, self-addressed envelope.

We would also be interested in corresponding with people interested in computer-generated music, particularly involving the Mountain Computer Music System for the Apple.

**Donna and Michael Witt
PO Box 55686
Valencia, CA 91355**

TRS-80 Compiler

I am attempting to compile a list of TRS-80 Model I programs that will (or will not) run on the Model III. I would appreciate any input from your readers.

To those who kindly respond, please mention if the program was on disk or tape—BASIC, SYSTEM or disk CMD file—whether run under Level II or DOS—and, if DOS, which one. If any changes are needed to be made to the program, what were they?

All those who send me information will be sent the compiled list (after a reasonable length of time to get all input) if an SASE is included with your information.

**Ken Knecht
1340 W. 3rd St. #130
Yuma, AZ 85364**

The Games People Play

I very much agree with your editorial on games ("Short-Lived Computer Games," April 1981, p. 6) and how they become boring after awhile. That is because there are no games with extended play value. I think they are improving, however; Super-Invader, ABM and Galaxian, as well as the Adventures, are entertaining. But there is a deadly sameness to the computer as an opponent, and even when you engage in classic games

such as chess and backgammon, it is not the same as playing against a live, variable opponent.

But that doesn't mean computers can't ever play games. There is still the pragmatic position of "guess what 100 kids surveyed reached for when they had a choice between a board game and a computer?"

There has to be an area in computing for the game. It is just that it hasn't developed and focused yet.

**Allan Turoff
Snedens Landing, NY**

Making It Work

I particularly enjoyed the article "Microcomputer Selection and Implementation" by Bruce T. Pace (March 1981, p. 120). It would be nice to see more articles like it which highlight the "hidden" factors in a successful data processing installation.

The average person has been led to believe that the computer is some mysterious black box that either works or doesn't. The fact is, it takes real effort and planning to make it work! This applies to large computer installations as well as small businesses contemplating their first machine, which may very well be a micro.

The temptation is there for a vendor to oversell and highlight the ease with which the computer will fit the customers' needs. And thankfully, usually it does. However, Mr. Pace makes a strong argument in favor of a vendor-independent consultant. When the neophyte computerist, or even the person who has only used a micro for games, goes out to acquire a business system, the requirements may not be altogether obvious. Who thinks of a contingency plan? Or, one point that almost got missed, can the system be expanded when the business grows? Thinking about and caring for these very important matters at the outset can save much heartache later.

All things considered, I thought Mr. Pace's article was quite thorough and fair. Keep up the good work!

**Daryl A. Frame
President
Discreet Computer Service, Inc.
Ventura, CA 93003**

Sorting Things Out

In "Sorta Super Fast" by Albert J. Marino (April 1981, p. 164), the algorithm in Fig. 1 which Mr. Marino has "never seen... implemented and might be unique," is Algorithm 175, Shuttlesort, by C. J. Shaw and T. N. Trimble of System Development Corp. (Santa Monica, CA), which appeared in the *Communications of the Association for Computing Machinery* in June 1963. The method is also known as sifting.

In the same issue, "A Better Bubble Sort" by W. A. Harrison and S. H. Sachs (p. 148) contains several errors in the flowcharts. First, the exchange takes too many steps and one too many temporary variables. Only one "temporary" is needed for the exchange:

$x = \text{key}_j$
 $\text{key}_j = \text{key}_{j+1}$
 $\text{key}_{j+1} = x$

If the point seems minor, consider that this code is executed often, and the records might be several bytes long.

The sort is not "stable"; i.e., identical keys will be swapped, destroying any previous ordering within the list, which may have been imposed by an earlier sort on another field in the case where the sort-key is not the entire record, or perhaps the file was created chronologically as events occurred to produce the records. If the sort-key is the entire record, the sorted list will look the same, so no apparent harm is done; however, the swap is unnecessary and wastes time. In the bubble sort, this may be the only swap during a pass, and will indicate the need for another pass, which is totally unnecessary. The swap should be done only if a key is greater than its linear successor in the list, to make this a stable sort.

Both the one-way and two-way algorithms fail to recognize that each pass "ranks" one key by migrating it to its final position in the list. The ranked key need not participate in subsequent passes; each pass handles a smaller unsorted list. For the one-way sort, the sorted list "grows" downward from the largest key, leaving the unsorted list at the beginning of the list; for the two-way, another list is growing upward, leaving the unsorted list in the middle. By failing to eliminate ranked keys, the "better" bubble may perform twice as many comparisons as a properly coded one-way sort.

Since no keys are eliminated from the unsorted list, and identical keys are swapped, and any swap requires another pass, the occurrence of identical keys will prevent the sort from terminating—an infinite loop. Eventually, the list would be sorted, but the identical keys would be the only swap performed, triggering another pass to do the same thing—forever.

The Bubble and Better Bubble sorts are by no means efficient. The Bubble is one of a number of sorting methods which are sensitive to the initial disorder of the list; in this case, positive displacement (a key occurring later in the list than its rank) is a big problem. The Better Bubble minimizes this sensitivity by creating an equivalent sensitivity in the other direction which helps only in some cases. For a reversed list, or any case where the sum of the positive and negative displacements is zero, the Better Bubble performs no better than the one-way Bubble.

**P. V. Pleschik
Wethersfield, CT**

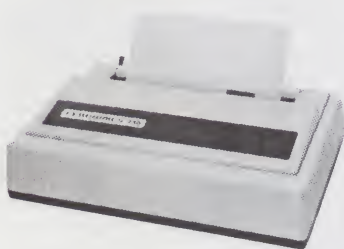
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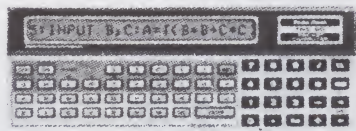
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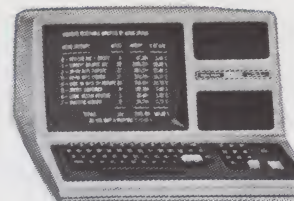
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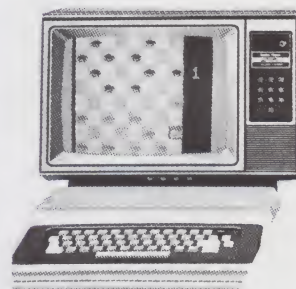
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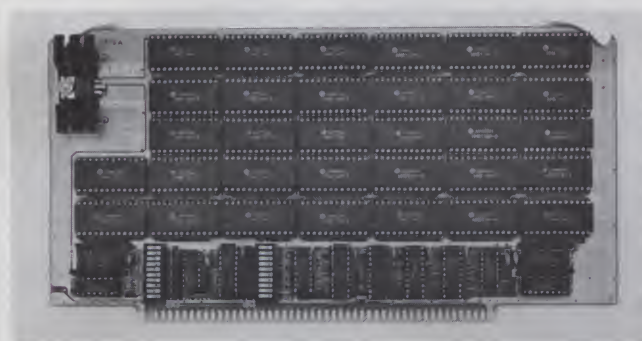
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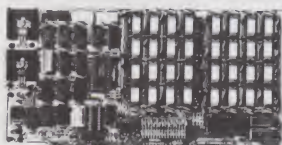
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Diagnostic II	\$ 84/\$20
Other	less 10%

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C Compiler	\$600/\$30
Pascal (incl C)	\$850/\$45

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FMS-80	\$649/\$45
dBASE II	\$629/\$50
Condor	\$599/\$30
T.I.M.	\$329/\$35

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Pascal/MT+	\$429/\$30
Pascal/Z	\$349/\$30
Pascal/UCSD	\$299/\$30
✓ Pascal/M	\$189/\$20

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SpellGuard	\$249/\$25
Spell Binder	\$349/\$45
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VTS/80	\$489/\$65

"OTHER GOODIES"

Tiny C	\$ 89/\$50
Tiny C Compiler	\$229/\$50
✓ CBASIC-2	\$ 98/\$20
Nevada Cobol	\$129/\$25
MicroStat	\$224/\$15
Vedit	\$ 99/\$15
Prof Time Bill (Asyst)	\$549/\$40
ESQ-1	\$1349/\$50
MiniModel	\$449/\$50
StatPak	\$449/\$40
Micro B+	\$229/\$40
✓ BSTAM	\$149/\$10

APPLE II

MICROSOFT

Softcard	\$292
Fortran	\$179
Cobol	\$574

PERSONAL SOFTWARE

✓ Visicalc	\$ 99
CCA Data Mgr	\$ 84
✓ Desktop/Plan II	\$159
✓ Visiplot	\$149
✓ Visiplot/Visiplot	\$229
✓ Visidex	\$159
✓ Visiterm	\$129
Zork	\$ 34

PEACHTREE

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DB Master	\$159
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STC	less 15%
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Type-n-Talk by Votrax.

ist's personal computer to talk back to him in intelligible English words and phrases. Used with any computer that has an RS-232C interface, Type-n-Talk lets you type an unlimited combination of English words and phrases on the keyboard. The computer will then "speak" the words as they are typed, or they can be held in the 750-character buffer until the user prompts the computer to speak them in entire phrases or sentences. The unit costs \$345.

Votrax, 500 Stephenson Highway, Troy, MI 48084. Reader service number 485.

(word and phrase underlining, tabbing, centering, etc.). The user can easily redefine the ASCII to IBM character and control codes translation. This feature allows most word processing programs to access the typewriter's automatic functions, without modifying the word processing program. Price is \$495. Reader service number 467.

Adjustable Dual Power Supply Kit

Recently announced by Jameco Electronics, 1355 Shoreway Road, Belmont, CA 94002, is the model JE215 ad-

Electronic Typewriter Interface

The ETI² interface from Mediamix, PO Box 67B57, Los Angeles, CA 90067, makes it possible to connect an IBM electronic typewriter model 50, 60 or 75 to any computer having a standard parallel printer port. The ETI² features a Z-80 microprocessor, 2K of RAM (text buffer) and total access to all of the typewriter's automatic functions



JE215 adjustable dual power supply.



The ETI² interface connects an IBM electronic typewriter with any computer's parallel printer port.



Sprinter 20 printer/plotter.

justable dual power supply kit. The supply provides independent adjustable positive and negative output from 5 to 15 V dc regulated. Separate adjustment for each supply allows the user unlimited applications for integrated circuit requirements. Power output for each supply ranges from 5 V dc at 500 mA to 15 V dc at 175 mA, and an on-board LED indicates power-on condition. Price is \$24.95. Reader service number 484.

20-Character Matrix Printer/Plotter

Sprinter 20, a high-speed matrix printer/plotter, provides program control of print mode. The Sprinter 20 prints a full 280-line CRT display in 28 seconds. The user can select parallel seven-bit ASCII or serial RS-232 with selectable

baud rates from 110 to 9600. The print mode is 20 x 7 dot matrix characters per line with 96 ASCII upper and lowercase characters. Programmable ASCII controls include automatic carriage return and line feed, right justification, form feed, graphic control, multiline feed and strip printing. Price is \$175.

Alphacom, Inc., 3031 Tisch Way, San Jose, CA 95128. Reader service number 481.

Floppy Disk Controller for Apple II

Lobo Drives International, 354 South Fairview Ave., Goleta, CA 93117, has a new disk controller board for the Apple computer. The LCA-22 is software compatible with Apple DOS and contains 256 bytes of on-board boot ROM. It



Lobo disk controller board.

MULLEN Computer Products

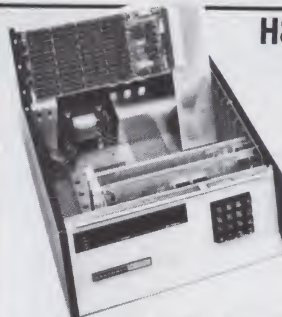
H8

PROTOTYPE BOARD

Now available for the Heathkit H8 hobbyist.

- Full-sized FR-4 board with heat sink/mounting brackets, buss connectors and polarizing key
- Designed for ease of external cable connection
- All plated thru holes .042" on .1" centers, power and ground traces

HKB-1 H8 PROTOTYPE BOARD \$30. kit



H8 EXTENDER BOARD

Our HTB-0 lets H8 owners troubleshoot their boards faster and easier. Each board can be extended above the computer for complete access to all circuits and components.

FEATURES

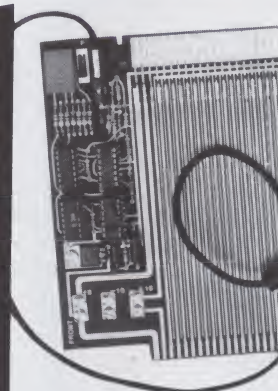
- Sturdy 3/32" board
- Molex 25-pin edge connectors with formed leads for easy scope probe attachment
- Jumper links in power lines makes current measurement and fusing easy

HTB-0 H8 EXTENDER \$39. (Kit only)

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- New brighter display, makes this very handy logic probe easier to use
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8 opto-isolator - INPUTS

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✓ 37

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The Microconnection direct connect modem.

will control up to four eight-inch single- or double-sided, single- or double-density disk drives with a total storage capacity of 4.4 megabytes. Controller card, cable, diskette and documentation are \$699. Reader service number 482.

Direct Connect Modem for the Atari

The Microconnection for the Atari is a direct connect modem which eliminates the need for acoustic coupled modems. The modem is connected to the computer console data port and employs software for 300 baud data I/O. It can be used for accessing The Source, Micronet and computer bulletin boards, and for data transfer with other computers.

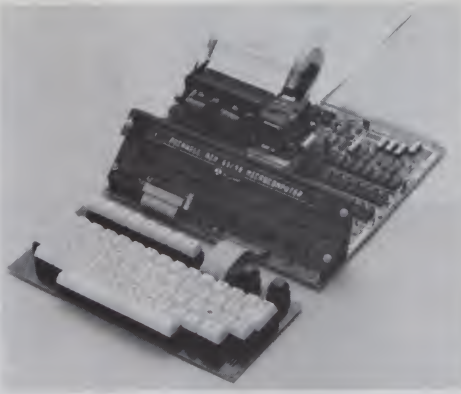
The Microconnection features a serial printer interface. Any printer capable of 300 baud will simultaneously reproduce whatever appears on the screen. A cassette recorder can be plugged into the Mi-

croconnection and will spool on-line communications for later playback. Price is \$249. Similar Microconnections are available for recently introduced TRS-80 models.

Microperipheral Corporation, 2643 151st Place, N.E., Redmond, WA 98052. Reader service number 475.

Interface Module for System-50 Computers

Percom Data Company, 211 N. Kirby, Garland, TX 75042, is offering a dual serial I/O module for System-50 computers. System-50 computers are developed around 680X microprocessors. The Percom dual-channel I/O card is designed for the 30-pin I/O bus, the SS-30 bus of System-50 computers. The module works with both older and newer versions of the SS-30 bus, and provides for an optional on-card bit rate generator for applications where a system baud clock generator



Rockwell AIM 65/40 microcomputer.

is not available. I/O card with bit rate generator is \$74.95. Reader service number 478.

Modular Microcomputer

The AIM 65/40 professional microcomputer comprises four modules—an R6502-based single board computer with on-board expansion to 65K, a printer with full graphic 280 x n dot matrix and 40-column alphanumeric modes, a 40-character alphanumeric display and a full ASCII keyboard with user-assignable function keys. The AIM 65/40 incorporates a ROM-resident software system which integrates all four modules. The interactive monitor software controls the system with single-keystroke, self-prompting commands, and supports software development with assembler, debug and control commands. A multifile text editor supports both line- and screen-editing functions. Price is \$1795.

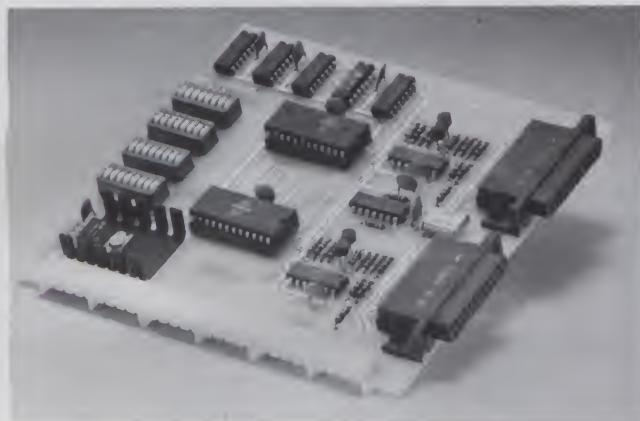
Rockwell International, Electronic Devices Division, 3310 Miraloma Ave., PO Box 3669, Anaheim, CA 92803. Reader service number 473.

STD Prototyping Boards

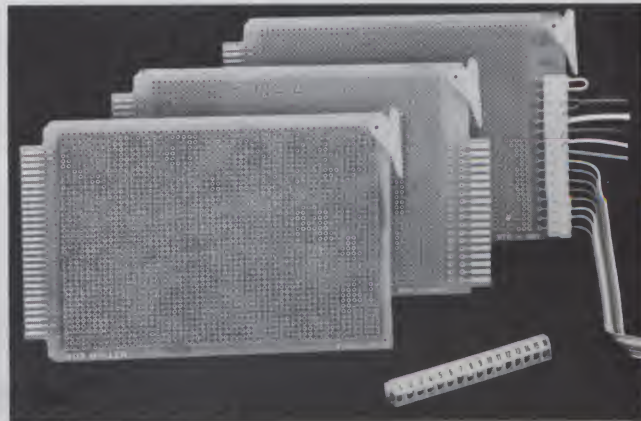
Bob Mullen, 2306 American Ave., #6, Hayward, CA 94545, has introduced a trio of prototyping boards for the STD bus. Each is .0625-inch FR-4 glass epoxy with .038-inch plated through holes on a .1-inch grid. The boards have solder plate over one-ounce copper and have 30 micro-inch gold on connector surfaces. The STD-001 has a 56 x 41 grid and is spaced to allow connectors for flat cable up to 50 conductors. The STD-002 has a 53 x 41 grid and a 36-position edge connector. The STD-003 has a 51 x 41 grid, equipped with a 16-position terminal strip capable of handling 15 A and 300 V. Prices: STD-001, \$29; STD-002, \$34; STD-003, \$39. Reader service number 468.

Three New Disk Controllers

Gimix, Inc., 1337 West 37th Place, Chicago, IL 60609, is offering three new floppy-disk controller boards for SS-50 bus, 6809 and 6800 systems. The DMA controller uses high-speed direct memory access for data transfers to and from system memory. It supports any combination of drives: eight- and five-inch, single- and double-track, single- and double-density—up



Percom's interface module for System-50s.



Prototyping boards for the STD bus.

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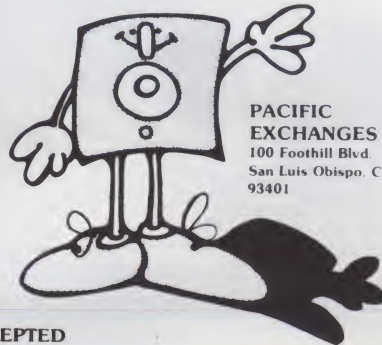


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- ☐ **SAVINGS:** Account management system for up to 20 separate Savings accounts. Organizes, files and displays deposits, withdrawals and interest earned for each account. Complete records shown via CRT or printer. \$14.95
- ☐ **CREDIT CARD:** Get control of your credit cards with this program. Organizes, stores and displays purchases, payments and service charges for up to 20 separate cards. Use for credit cards or bank loans. CRT or printer reports. \$14.95

UNIVERSAL COMPUTING MACHINE: \$49.95

A user programmable computing system structured around a 50 row x 50 column table. User defines row and column names and equations forming a unique computing machine. Table elements can be multiplied, divided, subtracted or added to any other element. User can define repeated functions common to a row or column greatly simplifying table setup. Hundreds of unique computing machines can be defined, used, stored and recalled, with or without old data, for later use. Excellent for sales forecasts, engineering design analysis, budgets, inventory lists, income statements, production planning, project cost estimates-in short for any planning, analysis or reporting problem that can be solved with a table. Unique cursor commands allow you to move to any element, change its value and immediately see the effect on other table values. Entire table can be printed by machine pages (user defined 3.5 columns) on a 40 column printer.

COLOR CALENDAR: \$29.95

HI-RES color graphics display of your personal calendar. Automatic multiple entry of repetitive events. Review at a glance important dates, appointments, anniversaries, birthdays, action dates, etc. over a 1 year period. Graphic calendar marks dates. Printer and screen display a summary report by month of your full text describing each day's action item or event. Ideal for anyone with a busy calendar.

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ELECTRONICS SERIES: Entire Series \$259.95

- ☐ **LOGIC SIMULATOR:** SAVE TIME AND MONEY. Simulate your digital logic circuits before you build them. CMOS, TTL, or whatever, if it's digital logic, this program can handle it. The program is an interactive, menu driven, full-fledged logic simulator capable of simulating the bit-time by bit-time response of a logic network to user-specified input patterns. It will handle up to 1000 gates, including NANDS, NORs, INVERTERS, FLIP FLOPS, SHIFT REGISTERS, COUNTERS and user defined MACROS. Up to 40 user-defined, random, or binary input patterns. Simulation results displayed on CRT or printer. Accepts network descriptions from keyboard or from LOGIC DESIGNER for simulation. \$159.95
- ☐ **LOGIC DESIGNER:** Interactive HI-RES Graphics program for designing digital logic systems. A menu driven series of keyboard commands allows you to draw directly on the screen up to 15 different gate types, including 10 gate shape patterns supplied with the program and 5 reserved for user specification. Standard patterns supplied are NAND, NOR, INVERTER, EX-OR, T-FLOP, JK-FLOP, D-FLOP, RS-FLOP, 4 Bit COUNTER and 8-BIT SHIFT REGISTER. User interconnects gates just as you would normally draw using line graphics commands. Network descriptions for LOGIC SIMULATOR generated simultaneously with the CRT diagram being drawn. \$159.95
- ☐ **MANUAL AND DEMO DISK:** Instruction manual and demo disk illustrating capabilities of both programs. \$29.95

MATHEMATICS SERIES: Entire Series \$49.95

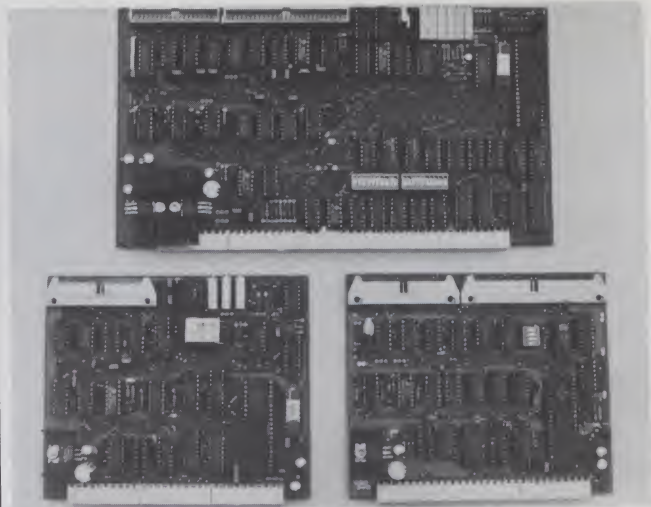
- ☐ **STATISTICAL ANALYSIS I:** This menu driven program performs SIMPLE LINEAR REGRESSION analysis, determines the mean, standard deviation and plots the frequency distribution of user-supplied data sets. Printer, Disk, I/O and edit routines included (32K min.). \$19.95
- ☐ **NUMERICAL ANALYSIS:** HI-RES 2 Dimensional plot of any function. Automatic scaling. At your option, the program will plot the function, plot the INTEGRAL, plot the DERIVATIVE, determine the ROOTS, find the MAXIMA and MINIMA and list the INTEGRAL VALUE. \$19.95
- ☐ **MATRIX:** A general purpose, menu driven program for determining the INVERSE and DETERMINANT of any matrix, as well as the SOLUTION to any set of SIMULTANEOUS LINEAR EQUATIONS. Disk I/O for data save. Specify 55 eqn. set (48K) or 35 eqn. (32K). \$19.95
- ☐ **3-D SURFACE PLOTTER:** Explore the ELEGANCE and BEAUTY of MATHEMATICS by creating HI-RES PLOTS of 3 dimensional surfaces from any 3-variable equation. Disk save and recall routines for plots. Menu driven to vary surface parameters. Hidden line or transparent plotting. \$19.95

ACTION ADVENTURE GAMES: Entire Series \$29.95

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- ☐ **SUB ATTACK:** It's April, 1943. The enemy convoy is headed for the CDRAL SEA. Your sub, the MORAY, has just sighted the CARRIERS and BATTLESHIPS. Easy pickings. But watch out for the DE STRIDERS they're fast and deadly. In HI-RES graphics. \$14.95
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Gimix floppy-disk controller boards.

to four drives total. The board features both a phase-locked loop data separator and adjustable write precompensation to ensure reliability, and can be used in 6809 systems running at 1, 1.5 and 2 MHz. Price is \$548.68.

The double-density PIO controller (6809 only) can be used at 1, 1.5 and 2 MHz in systems that have slow I/O circuitry on the motherboard. Price is \$348.28.

The Gimix 5/8 controller can be used in both 6809- and 6800-based systems. In 6800 systems the board can only be used with five-inch drives. Priced at \$226.58. Reader service number 470.

6809 Single Board Computer

The ADS 6809 S-100 single board computer brings the capabilities of the 6809 to the S-100 bus. The board features provisions for 2K of RAM, 4K/8K or 16K of EPROM, RS-232 serial communications with switch-selectable baud rates, parallel I/O ports using a PIA and simulated 8080-type I/O. A 2K monitor, ADSMON, is available to quickly get you up and running. ADSMON lets you examine and change memory and register, test memory, calculate relative offsets and load and punch tape files. Assembled and tested with 2K RAM and ADSMON, the price is \$449.50.

Ackerman Digital Systems, 110 No. York Road, Suite 208,

Elmhurst, IL 60126. Reader service number 469.

Intelligent Interface for Computer Control of Video Disks

SSM Microcomputer Products, 2190 Paragon Drive, San Jose, CA 95131, is offering a 6802-based interface unit that allows read-only video disks to be controlled from a computer keyboard. The Universal External Interface was designed and built by SSM for DiscoVision Associates, Costa Mesa, CA, which markets laser-based video disk playback equipment.

The computer operator can interrogate and directly access any portion of the recorded information; average access time is about one second. The UEI is available for either serial RS-232 use or IEEE 488 bus-based systems. Reader service number 472.

Tiny BASIC Computer Module

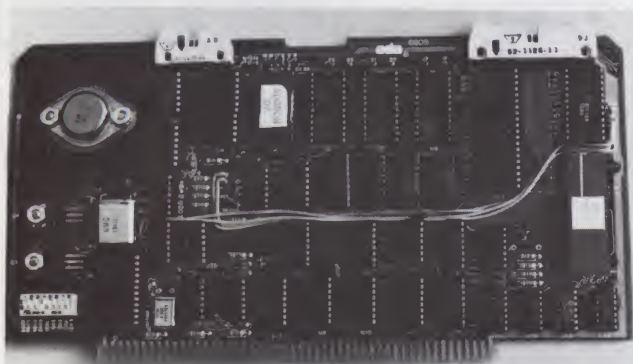
The K-8073 board from Transwave Corporation, R.D. 1, Box 489, Vanderbilt, PA 15486, provides varied design applications using National's INS8073 single-chip Tiny BASIC microinterpreter MPU. The K-8073 can be used as a development system or as a stand-alone dedicated computer. Features include serial communications, select-



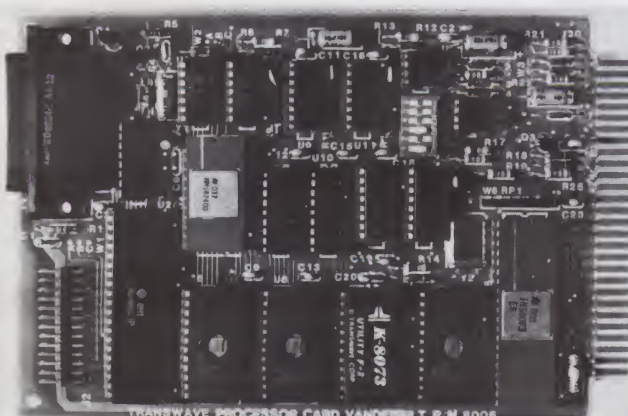
SSM's UEI puts video disks under control of a computer keyboard.

able from 110-4800 baud (RS-232), cassette tape in/out, 8K of plug-in EPROM for program storage with automatic execution, on-board program-mable EPROM slot and 1K of

local RAM. The computer comes with 2K ROM firm-ware. Supplied as a 4.5 x 6.5-inch card, or modular housed, for \$388. Reader service number 479.



ADS 6809 single board computer.



K-8073 Tiny BASIC module.

WORDPROPAC K

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**Robert Baker,
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353

TRS-80 RTTY System

Apple II Financial Planner

PL/1-80 Programming Language

Cheaptalk for the TRS-80

TRS-80 RTTY System

Mailbox is a disk-based RTTY system for the TRS-80 Models I and III. This program transforms a TRS-80 disk system with at least 32K RAM into an RTTY communications terminal. It features disk-based WRU with mailbox storage and retrieval of messages, programmable messages, and storage and replay of received text. Mailbox permits transmission and reception of BASIC and assembly source listings, object code and data files in Intel hex format with error checking. It communicates through the Macrotronics Ham interface or RS-232C interface. The price is \$150.

Macrotronics, Inc., 1125 N. Golden State Blvd., Turlock, CA 95380. Reader service number 496.

Financial Analysis and Modeling Package

Desktop/Plan II is a professional financial planning software package for Apple II personal computers, with AppleSoft, that speeds the preparation of financial statements, budgets, forecasts, projections and analyses. Desktop/Plan II offers such new features as high-resolution graphics plotting, the capability of receiving data from Personal Software's VisiCalc program and a moving cursor which helps simplify data entry. Be-

cause the Desktop/Plan II stores its formulas and values on diskette, a financial model larger than the computer's memory can be constructed. Package, including backup disk, \$199.95.

Personal Software, Inc., 1330 Bordeaux Drive, Sunnyvale, CA 94086. Reader service number 463.

PL/1 Language for Desk Top Computers

Digital Research's new PL/1-80 is available from Westico, Inc., 25 Van Zant St., Norwalk, CT 06855. PL/1-80 is an all-purpose application programming language for 8080, Z-80 and 8085 microprocessors. PL/1-80 programming systems comprise four major components: PL/1-80 compiler, Link-80 linkage editor, PL/1-80 run time library and RMAC relocatable macro assembler. The system generates industry standard Micro-soft relocatable code, so users can link load subroutines created by other language translators.

The package includes sample programs, three manuals and a programmer's quick reference guide. Price is \$500. Reader service number 497.

Cheaptalk for the TRS-80

Cheaptalk enables the TRS-80 to talk; a small audio amplifier connected to the cassette output plug is all that's

needed. Instructions are supplied for modifying your CTR-41 for use as an audio amplifier. Spoken words are digitized and stored in memory as complete self-contained subroutines callable by the BASIC SR statement or a Z-80 assembly-language call. Each word requires 512 bytes of storage, and you can store as many words as you have memory for. Don't expect stereo-quality audio, but it is intelligible. Cheaptalk cassette, \$19.95.

Alan Saville, PO Box 5190, San Diego, CA 92105. Reader service number 499.

Payroll Program for TI 99/4

Charles Mann & Associates, Micro Software Division, 7594 San Remo Trail, Yucca Valley, CA 92284, has announced Payroll I for the TI 99/4 computer. The system allows small businesses to operate a full weekly, semi-monthly or monthly payroll system. It calculates and records all federal taxes and FICA, and three user-formulated fields for state taxes, insurance, union dues and so on. The system can handle salaried, commissioned and hourly employees. It provides total retention of all individual payroll entries and a built-in quarterly audit balancing routine.

Payroll requires a single disk drive, a small micro printer, Extended BASIC and a 16K CPU. The program costs \$199.95. Reader service number 487.

Demo Package

Small Business Systems Group, Inc., 6 Carlisle Road, Westford, MA 01886, is offering a demo package of its TRS-80 Model II software. Samples of A/R, A/P, G/L, Invoicing, Inventory, Payroll, Client Billing and Name and Address-III are included. Variable speed capability allows a salesperson time to verbally address each screen. Dealers will find the unattended mode useful as an eye catcher. The package includes the SBSG catalog, demo diskette and manual. The price is \$50. Reader service number 493.

Word Processing Tools

The Word is a complete toolkit of programs for spelling checking and correction, word counting and other word processing functions. Compatible with CP/M 1.4 and 2.2, The Word works in conjunction with any CP/M text editor or word processor. It contains a 40,000 word dictionary, and will find and list spelling errors in any text file. Other included programs will flag the misspelled words for easy correction with your text editor, locate possible correct spellings automatically and help you make and solve crossword puzzles. Eight-inch disk and manual are \$75.

Oasis Systems, 2765 Reynard Way, San Diego, CA 92103. Reader service number 489.

Apple Sacks

New software packages for the Apple II are available from ComputerMat, Box 1664F, Lake Havasu City, AZ 86403. Apple Sack I contains 40 Applesoft programs, including a selection of business, game, utility and home applications. Apple Sack II is a collection of TV trivia questions, and is written in Integer BASIC. Apple Sack III contains eight adventures and simulations from the old west to the new space frontier, available in Integer and Applesoft. Apple Sack IV contains utility programs allowing you to fix, catalog, copy, sort, transfer, find, remove and perform other functions with your Apple, and is available in binary, and Integer and Applesoft BASICs. Each sack is \$24.95. Reader service number 495.

New TRS-80 Operating System

LDOS is an operating system that bridges the gap between TRS-80 microcomputers: compatibility with Model I is available now; compatibility with Models II and III will be ready soon. LDOS is fully device-independent, supporting five- or eight-inch floppy disks, double- or single-sided, double- or single-density and hard disks. It provides keyboard type-ahead, auto-repeat and a keystroke multiply feature that allows users to define phrases for each alphabetic key. It contains all standard library commands and an extended library, extended utilities, enhancements to BASIC and its own set of device drivers.

Lobo Drives International, 354 South Fairview Ave., Goleta, CA 93117. Reader service number 494.

Smart Terminal/File Transfer Program

Crosstalk is a smart terminal and file transfer program for the Hayes Microcomputer Products Micromodem 100, and is available for CP/M or North Star DOS. The program acts like a sophisticated smart terminal, allowing the user to

capture data from a remote computer system and save it to a disk file, or to send a disk file to the modem. The program features auto-dial and redial; auto-answer; selectable baud rate, word length, parity and duplex; concurrent printer and video; user-definable break key; and disk directory command. It uses command files to store setup information for frequently called numbers. Price is \$75.

The Microstuf Company, Box 33337, Decatur, GA 30033. Reader service number 498.

Genealogy Program for Heath Computers

Commsoft, 665 Maybell Ave., Palo Alto, CA 94306, is introducing Roots 89: A Software Tool to Track Your Ancestors. Roots 89 can store, retrieve and display thousands of facts about your family. It is seven linked programs designed to list family members, display and print family group sheets and pedigree charts, compute relationships and show important anniversaries for each day of the year. The documentation provides an extensive course in genealogy. Price is \$124.95. Reader service number 464.

Word Processor for TI Systems

Word-990 is an interactive word processor that lets you see your document exactly as it will appear when printed. It features word fill, justify, insert, delete, overtype, center, extract, search, append and many other commands. Word-990 runs in SBC BASIC on the Texas Instruments DS990 computer series, and is priced at \$495.

Synergistic Systems, Cobble Hill Road, E. Thetford, VT 05043. Reader service number 491.

Upgrade Your DiskAte Operating System

DocuMint was developed by Responsive Logic, 156 Donald St., Oregon City, OR 97045, to improve the appearance of

text-edited copy. It works with the Thinker Toy Discus 1 and DiskAte operating system. DocuMint produces true proportional spacing by changing the size of spaces between characters, and is used with a proportional space printer such as the Centronics 737. It permits automatic pagination, standard or customized formatting and variable line spacing. DocuMint is entirely menu driven. The eight-inch single-density disk costs \$85. Reader service number 490.

North Star Enhancement

N*Sort is an addition to North Star BASIC that allows programmers to sort one- and two-dimensional arrays or strings with a simple BASIC statement, such as "SRT A\$, LEN(A\$),1". N*Sort incorporates one-level sort keys for both numeric and string sorts, and is implemented as a Shell-Metzner machine-language routine that is about 1800 percent faster than an equivalent algorithm in BASIC. The tandem version co-loads with BASIC, and the ROMable version places N*Sort outside BASIC's memory region. The package includes diskette, manual and BASIC program which interfaces N*Sort to any release 4-5.2 North Star BASIC. Price is \$89, plus shipping.

SZ Software Systems, 1269 Rubio Vista Road, Altadena, CA 91001. Reader service number 492.

Software Tools for CP/M

Programming languages and other software tools for CP/M are now available, on standard eight-inch single-density disks, from The Software Toolworks, 14478 Glorieta Drive, Sherman Oaks, CA 91423. The C/80 C Compiler implements a large subset of the C programming language. LISP/80 is an 8080 implementation of the well-known artificial intelligence language. Structured programming constructs for Microsoft Fortran are provided by the RATFOR preprocessor. It comes with complete source code, written

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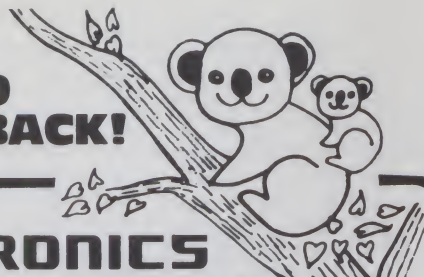
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in RATFOR, and sample programs. The Text program is a versatile text formatter. When used with a good file editor, Text supplies word processing capability usually found only in much costlier systems. Prices range from \$20-\$40. Reader service number 465.

Foreign Language Word Processor

Hebrew II is a useful tool for education and everyday communication. You can type and edit a page at a time of Hebrew text. You can also use it to label graphs, maps and pictures on the Apple II screen and then print them. The finished text or picture may be saved to disk and/or printed on the Silentyper printer. In accordance with common usage, vowels are not provided at this time. Hebrew II is perfect for teaching students Hebrew spelling and typing. Printed pages can be submitted to the teacher and the page can later be edited on the screen to show the recommended cor-

rections. It requires 48K of RAM, Applesoft in ROM and one disk drive. Price is \$60.

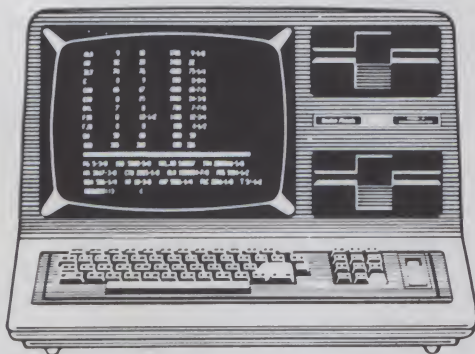
Michael Heckman, 11 S. Hancock St., Madison, WI 53703. Reader service number 462.

Asset Management System

UNIDEP is an asset management system. It calculates depreciation, investment credit and bonus depreciation. It performs automatic subtotalling, as selected by the user. It also files information about each asset. With UNIDEP you can do projections to experiment with various options. The user chooses the relevant options, including depreciation rate, term, length of reporting period, when and how many periods to print and when to update information. It runs on a 32K Apple or 64K TRS-80 Model II, with disk drive. Price is \$99.

Natural Language Systems, 411 Barber Ave., Ann Arbor, MI 48103. Reader service number 486.

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FIQ can be used by anyone. It requires no special skill, just the ability to type. Ar-

ticle references to be stored can be pre-selected and then entered into the system by a secretary or assistant. The contents of entire file cabinets can even be indexed and stored!

FIND IT QUICK requires a minimum system consisting of a TRS-80 Model I Level II with 16K of RAM, an Expansion Interface with 16K of RAM and at least one disk drive. Up to 1080 items can be stored on one data disk. Instant Software's Tiny DOS operating system is included on the program disk so that you can use the program without fuss or bother.

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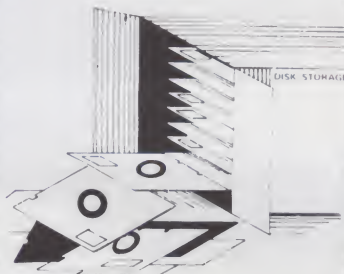
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6800 Tape-Based Sort Processor UniFLEX Multi-User System ACIA Prototyping Board

Dr. Preble's Programs' LDP-3

While many system designers feel that only a dual-disk, 48K system is adequate for the small-business user, there is much that can be done with a small tape-based system. It may not allow a full-feature general ledger, billing package or high-speed program loading, but the cassette system will perform many tasks for the home and small-business owner at a reasonable cost.

A small system can easily be used as a mailing list manager. Dr. Preble's Programs (102 W. Madison St., La Grange, KY 40031) is offering a fast sort program for the 6800. The LDP-3 is priced at \$14.95 and is supplied in both source and object on an AC-30-compatible tape. The user's manual contains full operating instructions and a commented source listing.

The LDP-3 is a machine language sorting program that can easily be adapted to almost any 6800 system. The program itself takes less than 400 (hex) bytes of memory. While a 16K system will allow 150 addresses to be sorted, even an 8K system will perform a useful task. The more user memory available, the more items the LDP-3 will sort.

The Sort Processor is designed to sort files created with a text editor. The TSC Text Editor is the ideal companion to the LDP-3. It is easily obtainable and is reliable.

The editor creates a file of addresses and names up to 256 characters per line. A typical address line is:
GRAPHICS 1,345 MAIN ST. RACINE WI. 53403
At the beginning of the file, before the first name, a special start-of-file character occupies one line. This can be any non-alphanumeric character such as the up arrow (^). This signals the LDP-3 that the file is starting. The last line created by the editor is an end-of-file character. Again,

this can be any unused character. It tells the LDP-3 that the end of the file has been reached. The editor is used to save the address file on a cassette tape.

The Sort Processor is loaded and the tape file is input and sorted. The sorted file can be listed on the terminal and saved to tape, where it can be used to print a sorted address list using BASIC, an editor or a short assembly-language printer-driver routine.

The file can be sorted by fields; that is, by name, address, city/state or zip code. All that is required is to insert a sort header before that desired field. In the above example, the period (.) is used to identify the zip code field. The character can be placed before any field in the line. Since the Postal Service requires bulk mailings to be sorted by zip codes, the LDP-3 can create an address file sorted by zips. These will be in order when they are printed as address labels. Even with only 150 pieces of mail to sort, the LDP-3 will save time.

If your lists include both upper and lowercase items, the LDP-3 will convert the lowercase to uppercase for the sort. This will prevent an item such as Able from being sorted before aardvark. In ASCII, uppercase letters have a lower value than lowercase letters.

With a 300 baud system, it takes about 60 seconds to load 50 names and addresses from a cassette. These can be sorted by name or zip code in about 12 seconds. While the LDP-3 does not have the program loading time of a disk system, its cost is within the reach of almost everyone.

Since the LDP-3 can sort almost any type of file, it has many uses and can be used for more than address sorting. If your computer club's roster is on a tape file, it can be sorted alphabetically by name, address, system or special interests. It would be easy to maintain a file of

your library or record collection and keep it sorted by title, author or subject. The more you use the LDP-3 Sort Processor, the more uses you will find for it.

As well as sorting a file from tape, the LDP-3 will also sort any continuous block of memory. It should not be difficult to re-assemble the Sort Processor in any convenient memory location so it is co-resident with an editor or BASIC.

The program is self-documenting while running. It asks the user for the parameters and proceeds with the sort. It is easy to sort a file first by name and then by zip codes.

When the LDP-3 is started, the user is asked to supply the following parameters he selected: the record separator (usually a carriage return), the sort header (for a field sort), the start-of-file and end-of-file characters, perform the search from tape input or memory and uppercase conversion. If a long file is to be sorted, a verification option is available. This prints a plus sign (+) on the terminal for each cycle of the sort.

Do you need the LDP-3? If you do not use a disk and have lists that need to be alphabetized and saved, by all means, the LDP-3 Sort Processor will be a useful addition to your system.

**Dennis Doonan
Racine, WI**

UniFLEX

Today's technology makes it possible to develop software comparable to that for much larger installations. The UniFLEX operating system by Technical Systems Consultants (PO Box 2570, West Lafayette, IN 47906) takes advantage of the power of Motorola's 6809, and will also be available for the 68000.

UniFLEX is based primarily on UNIX, an operating system developed by Bell



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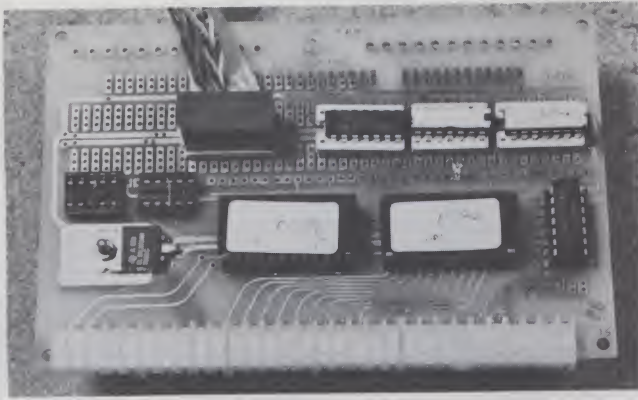
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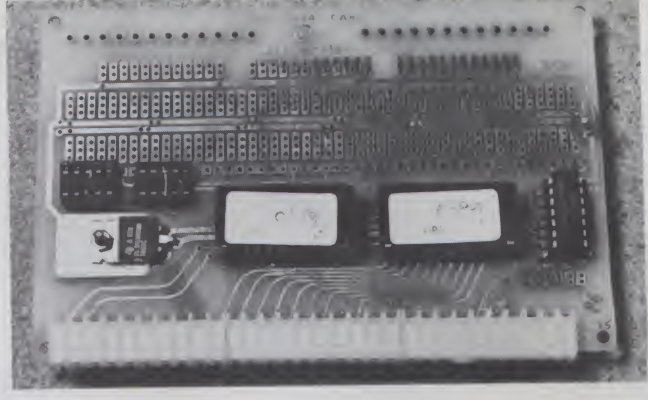
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The QRC 80-215 in use as a dual RS-232 serial interface.



The QRC 80-215 assembled and ready to use for prototyping.

Laboratories. UniFLEX was not designed for the hobbyist or very small business with only one or two users; it is a true multitasking, multi-user system, allowing up to 12 users under the 6809 version. It offers an environment similar to that of larger systems, where each user is assigned a name and password required to log into the system. A complete log of user activity makes UniFLEX ideal for an educational institution, where such activity should be monitored.

Being a true multi-user system means that each user can be running a totally different program. For example, one user may be doing word processing, while another user is assembling a source file. This ability makes UniFLEX well suited to the office environment.

Technical Systems Consultants will write custom versions of UniFLEX for nonstandard systems, so the hardware configuration may vary. The standard version requires at least one video display terminal with lowercase capability, one serial interface card, a Southwest Technical Products computer system with an S/09 mainframe with 128K of memory and the DMAF-2 eight-inch disk system. More RAM, serial interfaces and terminals are supported, as well as the CDS-1 hard disk system by SWTP.

Technical Systems Consultants offers their major software in versions compatible with UniFLEX. Their editor and assembler are included with the initial purchase of UniFLEX, and a multi-user version of their high-speed BASIC interpreter is also available. Anyone who buys UniFLEX should not fear the lack of software support; other software companies are already offering compatible software.

In addition to multi-user operation, UniFLEX has two other important features. First, it can run background jobs. An operator can, for example, print a company's payroll checks using a program written in the BASIC interpreter and be editing text at the same time, by running BASIC under a background task.

This can lead to a problem which is solved by this second feature: UniFLEX

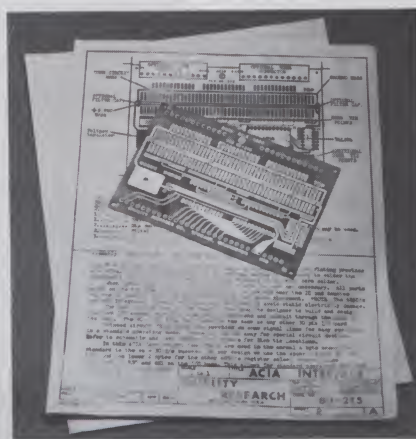
can swap to an external device. Swapping can be done with the eight-inch disk system, with some loss in speed. With the hard disk, the operation is almost invisible to the user. Swapping, in effect, gives the system more memory to do its multi-tasking operations. Of course, if speed is really a problem, more memory can be added to the system that will be used for these swapping operations.

In the future, more companies will be offering operating systems based on UNIX by Bell Laboratories. Those with eight-bit microcomputers will probably be out of luck, because most of them lack the sophistication required to develop such a system. Technical Systems Consultants even admitted that no attempt at a 6800 version of UniFLEX will be made. But in the 16-bit market, this kind of software can be expected to flourish, and UniFLEX will certainly be the model for all those who follow.

Tim Chase
Milwaukee, WI

QRC ACIA Board

Quality Research Co. (Box 7207, Spokane, WA 99207) offers a convenient way



The QRC 80-215 ACIA prototyping board and documentation as received.

to design a custom, dual-serial interface for your SS-50 system. The 80-215 ACIA card is a prototyping board designed to fit one 30-pin I/O slot. It is a quality, double-sided, plated-through board with data and control lines etched for two 6850 ACIAs.

The following signals are brought to an ample prototyping area: I/O select, R/W, \emptyset 2 clock, reset, IRQ, NMI, user defined and index lines, ± 12 V, ground and the onboard regulated +5 V lines. Baud clocks, TX and RX clocks, and the TX and RX data lines are separate for each ACIA. Baud rates and interrupts can be selected for each 6850 by jumpers. There are five inverter gates available for user design. It will be easy to design a dual RS-232, current loop, or TTL interface or any combination on a single board. The 80-215 is set in the standard operating configuration and is easily changed by the user.

Two 6850 ACIAs occupy the four-byte set of address locations used on the SS-50's I/O bus. This allows conventional operation with a second ACIA on the board. The upper two address bytes are used for one 6850. The lower two bytes are used for the second 6850's register select lines controlled by RS0 and RS1 on the I/O bus. With an SWTP 6800 and SWTBUG, the QRC board cannot be used on the control port. SWTBUG expects both address pairs of port 1 for a single ACIA. Other than that, the 80-215 can be used on any port to allow two terminals, printers, modems or any combination to occupy a single I/O slot.

Although there is no solder masking or component labels, assembly is easy and only takes a few minutes. The documentation includes assembly information, a component layout and a schematic.

Shipment was prompt and service personal. The 80-215 bare board is \$8.50 and the bottom edge connectors are \$3 postpaid. If your design requires a 6820 parallel interface, QRC offers the 80-205 PIA prototyping card (see *Microcomputing*, July 1980, p. 14, for details).

Dennis Doonan
Racine, WI

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Computerize Your Small Business A/D and D/A Interfacing Computers for Home Use Z8000 Assembly Language Programming

How to Computerize Your Small Business

Jules A. Cohen
Prentice-Hall, Inc., 1980
Paperback, 171 pp., \$7.95

Even though this book is not concerned with *microcomputers* for the *very* small business, it should be required reading for anyone trying to sell computers to businessmen. It gives necessary insight into the thought processes and planning of the business owner and, if he is smart enough to hire one, his consultant.

The author begins with an explanation of data processing and the computer components required, without mentioning specific makes and models. This ensures that the book is not obsolete by the time you get it. He then goes through the steps involved in analyzing the system requirements, writing a request for proposals, avoiding being sidetracked by fast-talking salesmen and creating an evaluation matrix to be used for the buy decision.

Two specific system examples are given. The first is for a business accounting application, the second for a large word processing system. As Cohen points out, the large system might be better implemented by a collection of smaller systems (enter the microcomputer).

About a third of this small manual is taken up with the description of the system requirements for an eight-user word processor with database management functions. Included are a lot of useful boilerplate, report formats, file organizations and CRT screen layouts for the input operators. These forms alone are worth the modest price of the book. They can provide a computer salesman with graphic examples of how a system should be organized and what it can do for the customer.

Whether you are thinking about or

planning a computer system for your own business, advising a businessman on computer selection or trying to sell a business computer, you should read this book. When you are done, keep it handy to show the potential customer. You might have to explain that microcomputers differ from the examples given, but that the difference is only one of scale. The planning, analysis and evaluation decisions that are the subjects of the book apply equally well to systems large or small.

Overall, this is a most informative book, logically organized, and both easy and interesting to read. What we need now is for someone to write a similar book aimed specifically at microcomputers for the tiny business, accurately explaining their capabilities and limitations. Properly done, this could be a big seller.

Until then, I'll keep this volume handy as the best "how-to-computerize" text so far.

Ken Barbier
Borrego Springs, CA

Microcomputer Interfacing Handbook: A/D and D/A

Joseph J. Carr
Tab Books, Inc.
Blue Ridge Summit, PA
Softbound, 350 pp., \$8.95

"If you've been itching to do more with your microcomputer than just play games, this thorough introduction to using analog-to-digital and digital-to-analog converters has all the answers you want. This big new manual not only tells you how to interface both A/D and D/A converters with all kinds of microcomputers—it shows you how to do it as well."

The above blurb from the back cover of this book is as good a two-sentence summary of the book as can be given. This

book is *complete*. It treats virtually every aspect of digital and analog interfacing. Since we live in an analog world, such interfacing is necessary to measure or control analog quantities with our digital computers.

I would not recommend this book as a first text in analog conversion. Much of the material assumes a familiarity with electronics, especially op amps and TTL circuitry. I personally found the material easy, but then, I teach electronics to college seniors and graduate students. A knowledge of algebra is a must, and a very small amount of calculus is used.

There are chapters which are tutorials on subjects in electronics, such as an entire chapter on the basics of op amps and a chapter on analog switches. Both of these speak in simple terms, pointing out the salient features of each, and leading the student through the material on a step-by-step basis, with example calculations.

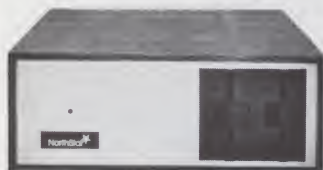
These chapters are painfully short, though. For example, there is not much discussion on the limitations of op amps in ADCs and DACs, such as slew rate and frequency response (I learned the hard way that an LM741 isn't fast enough to substitute for an LM310), and the discussion of op amps as comparators could be beefed up, since comparators are the heart of many ADCs.

The writing style is mixed. Portions of the text are very easy, giving step-by-step instructions through the basics, and then become quite technical in the heavier topics. The book is really more oriented toward A/D and D/A design than as a beginning textbook for the person who wants to measure or control analog voltages with a digital source. A beginner would find this book tough going—it's not for the person who just wants a circuit he can whack together without understanding what it does.

For someone who is familiar with electronics using integrated circuits, even on a black-box level, the book is quite useful.

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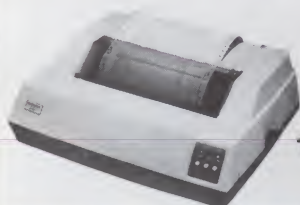
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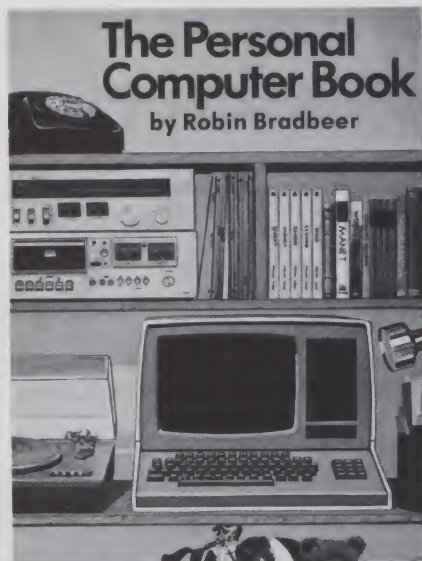
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Indeed, it could be an invaluable reference! The major selling point of this text is its completeness. Everywhere you look there are diagrams, examples of use and sample calculations.

One point I like about the book is that it begins with a discussion of analog and digital signals. Oftentimes the conversion method used depends on the signals available or desired.

There is a complete comparison of A/D and D/A conversion methods over several chapters, giving the advantages and disadvantages of each, how they work, and how well they work. Included with this is a discussion of precision, reference voltages, sample and hold errors, multiplexing, sources of error, limitations to precision and the like.

There is an entire section on analog to digital conversion rates which is very good. It tends to be application-oriented, as well. The thrust of A/D conversion is toward conversion of dc voltages, or of ac sampling and digitizing. Specific examples are given in the cases of dc voltmeters or digitizing of an electrocardiogram and Fourier synthesizing. A point I find lacking, mostly because I do a lot of it in my work, is fast pulse-height analysis (PHA), where the amplitude of a pulse only 2 μ s wide must be digitized several thousand times a second, at random times. The material is there, but requires some searching.

The rest of the book is devoted to specific examples and applications. There is an analysis of many major D/A and A/D chips, with application circuits based on these. The book provides pin-out and specifications. This is helpful in that the reader won't have to reinvent the wheel, but limiting in that the application presented may not be the reader's application. There are no examples of a converter built up from scratch, other than in general terms.

D/A applications covered are motor control, wave-form generators and an

X-Y display.

Two chapters cover interfacing with microprocessors. The D/A chapter is mostly a discussion of address decoding, while the A/D chapter goes into Tri-state logic, data buses and a long explanation of the use of interrupts for on-demand processing. There is also a chapter on software data conversion techniques which will be of great interest to the hardware-poor computer hobbyist who nonetheless likes to "program around" a problem and who would like to try his hand at analog measurement control.

When I evaluate a book for adoption to one of my college classes, I ask myself three questions:

- 1) Is it complete—does it cover the material I want?
- 2) Does it have lots of examples and diagrams? and
- 3) Will it be understandable to my students?

In the case of this book, the answer to questions 1 and 2 is an emphatic "yes." Question 3 gets a qualified "maybe." It's not for someone who doesn't know an op amp from a NAND gate, or for the games programmer who's never had the cover off his TRS-80. But for the experts who read *Microcomputing*, or for the intermediate-level hardware hacker, the book contains a wealth of information, and is highly recommended.

Dr. Gordon Wolfe
Oxford, MS

The Personal Computer Book

Robin Bradbeer
Input Two-Nine
Bradford, England, 1980
Paperback, 220 pp.

Owning Your Own Computer

Robert L. Perry
Everest House
New York, NY, 1980
\$10.95 paperback, \$15 hardcover; 224 pp.

The back cover of *The Personal Computer Book* says that Bradbeer is a "free-lance writer on personal computing." Is this anything like being a free-lance writer on drugs? Apparently so, if this book is any indication. Bradbeer talks about computers with as much restraint as Timothy Leary discussing sunshine acid.

According to Bradbeer, micros will soon be "as natural a part of the home as the TV set is today." Not one to shy away from the challenges of redundancy, he says five pages later that we will have a "total domestic information and data processing system... which we will come to find just as natural as today's electric cooker, washing machine and colour TV."

These are absurd and premature assumptions. In the first place, electric

cookers, washing machines and color TVs are not a natural part of millions of homes, and to state so is to perpetuate a middle-class fallacy. In the second place, the microcomputer is nowhere near being the plug-in appliance that Bradbeer's remarks suggest. In the third place, the consumer has yet to be convinced that microcomputers are the necessity that many micro enthusiasts would like to believe.

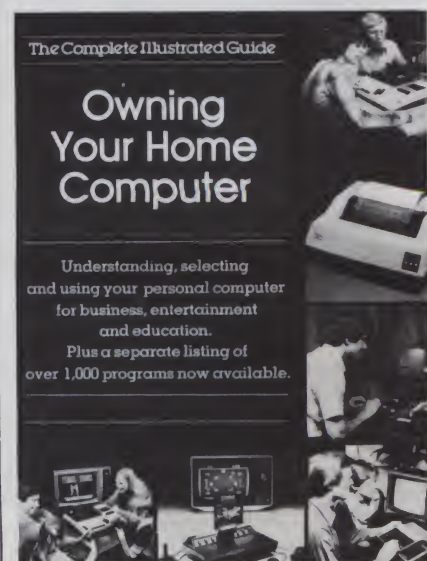
Bradbeer's attitude reflects one glaring fact—micros are not yet able to sell themselves. They need people to keep reminding the public of all the marvelous tasks they can perform.

Bradbeer's irritating overenthusiasm is the least of this book's problems. Unfortunately, the book is also a prime example of the lamentable decline in quality book writing and editing.

Bradbeer's grammar is atrocious. Witness this example: "The last thing wanted is for your supplier, who you will depend on a great deal to start off with, not to go bust just when you need him!" This sentence is so convoluted that it means exactly the opposite of what it's supposed to. The entire book is written in this awkward style. It certainly proves that Americans aren't the only ones who can massacre the language.

What's more, the book is riddled with inconsistencies and typographical errors. Bradbeer freely alternates, for example, between "Basic" and "BASIC," sometimes on the same page. A section on interfaces refers twice to the "IEEE-4888" before the mysterious extra 8 disappears.

As for the content, you'll find no surprises here. Bradbeer covers all the usual ground—how a computer works, binary numbers, computer languages, input and output devices, storage and printers. He also provides a list of manufacturers, distributors and computer clubs in the U.K. and a list of English-written magazines. And, of course, he includes a chap-



ter on the various micros and peripherals on the market, which was outdated before the book even hit the press.

But ultimately, it's Bradbeer's ungodly English that sinks this book. Perhaps someone at Input Two-Nine will have the decency to edit it before the second edition comes out.

Robert L. Perry's *Owning Your Own Computer* suffers from the same kind of hyperbole that Bradbeer's book does. Perry, too, wants the reader to know about "all the fantastic ways to use a home computer," and predicts that in 1995, "we'll wonder how we ever lived the way we do without our home computer." But his book is more extensive, and his writing is the work of a professional.

Perry focuses much of his attention on the broader and more significant micro applications—namely, those related to information networking. In fact, it takes him only three pages before he's discussing teletext, viewdata, The Source, CompuServe and the Electronic Information Exchange System. He explains these uses in detail in a later chapter. Perry seems to recognize that information retrieval is what will ultimately sell the home computer.

Like Bradbeer, Perry includes the standard material on how computers work. He also devotes a chapter to a short history of computers, another to buying a micro, and two more to micros in education and at work. One short chapter covers the uses of micros in helping the handicapped.

Unfortunately, Perry waters his book down with a 67-page rundown of the major microcomputers. Again, while these descriptions might give the reader an idea of what kinds of micros are on the market, the section is already out-of-date and incomplete. He also includes quite a lot of filler material: a silly chapter entitled "Ninety-nine Common Things to Do with a Home Computer," an obligatory gaze into the crystal ball and an appendix listing 1050 computer programs.

Despite its flaws, *Owning Your Own Computer* is an adequate introduction for the newcomer. If anything, it provides too much information, but the discriminating reader should be able to pick out what he needs.

The Personal Computer Book, on the other hand, will be useful only to those with plenty of patience and deciphering skills.

Eric Maloney
Microcomputing Staff

28000 Assembly Language Programming

Lance A. Leventhal, Adam Osborne and Chuck Collins
Osborne/McGraw-Hill, 1980
Softcover, 898 pp.

Osborne/McGraw Hill is probably one

of the most experienced documentation companies around. Adam Osborne's original organization was among the first to produce microprocessor/microcomputer books.

And it shows. *Z8000 Assembly Language Programming* is another in a long line of highly descriptive books. Using Osborne's typical typesetting feature (important information is given in **bold-face** type), this book explores the ins and outs of Z8000 programming.

The book is divided into 17 chapters. The first chapter contains an introduction to assembly-language programming, and a brief discussion of high-level languages. The second chapter describes the features of an assembler. Both of these chapters could have been left out—they seem somewhat out of place, and perhaps would be better suited for *An Introduction to Microcomputers: Volume 1—Basic Concepts* (Berkeley: Osborne/McGraw-Hill, 1980).

The third chapter describes the Z8000 instruction set, and is 376 pages long. Operating modes are described, as are registers, addressing modes, and every other facet of the Z8000 instruction set. I found one peculiarity in this chapter. In discussing the Z8000 flag and control word register, this book described a bit they called the Extended Processor Architecture bit. According to this book, the bit is used to determine how extended instructions are to be processed by external devices. However, the Advanced Micro Devices literature (AMD is the second source for the Z8000) describes this bit in a different manner. The *AmZ8001/2 Processor Instruction Set* book (Advanced Micro Devices, 1979) says the bit doesn't exist at all. I suspect that the device was revised after the Osborne/McGraw-Hill book was printed, although the AMD book was corrected in 1979.

The next six chapters provide examples of the use of the Z8000. Simple programs, loops, code conversion, arithmetic problems, tables and lists, and subroutines are covered.

Chapters 11, 12 and 13 describe I/O, interrupts and memory configuration. Some discussion of the Z8001 Memory Management Unit is included in chapter 13. Chapter 13 does a pretty good job of describing how the Z8001 works in a large memory environment.

The remainder of the book is interesting reading for those who would like to get a picture of overall software design. Chapter 14 discusses problem definition and program design. This chapter is not tailored specifically to the Z8000, but is general in nature. Chapter 15 talks about debugging and testing software, and chapter 16 discusses documentation and redesign.

The last chapter in the book has two sample projects: a digital stopwatch and a digital thermometer (both, I'm afraid, overly simple uses of a device like the Z8000). The software design process for

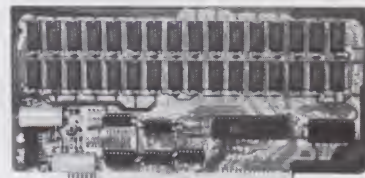
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Overall, this book covers the Z8000 pretty well. I'd give it points for readability and sheer volume. It's a big book, though well organized, and probably worth the price.

Using CP/M, A Self-teaching Guide

Many people's first encounter with an operating system is with Digital Research's CP/M. Unfortunately, CP/M's documentation is not written for novices. It has been described as, at best, "difficult to read" and, at worst, "a user's nightmare." To someone unfamiliar with exactly what operating systems are for, what they do, what files are and so on, CP/M's six accompanying manuals provide no place to start.

in commands (e.g., DIR, SAVE) and some of the commonly used transient programs (such as PIP and STAT) and includes three chapters on the CP/M editor, ED.

The book is broken into chapters, the chapters are broken into sections, and the sections are broken into frames; each frame is between a half and a whole page of text followed by questions. This is the self-teaching format. The last time I used a book of this format to learn something completely new, I found it tedious. But I also learned what I wanted to learn rather quickly. I was disappointed to see that the frame questions did not include interactive use of a machine. (One of the nice things about learning how to use a computer interactively is that it usually tells you straight out when you're wrong; no

However, if you are not a complete novice, you will be frustrated by the tone and contents of this book. It provides an introduction to only the easiest parts of CP/M. It can't go into the assembly-language interface, which is where most people really get stuck, since it can't assume the reader knows assembly language. Similarly, it can't describe the use of DDT, the interactive debugging tool. And the programmed teaching format greatly reduces its value as a reference book.

The last word: If you've had your CP/M for awhile and are one of the many people frustrated with the documentation because you can't understand the nitty-gritty details of CP/M, look somewhere else. But if you're a beginner, or if you're buying your computer to use prepackaged software or to start writing BASIC

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and it happens to use CP/M, then this book will make getting started easier.

Richard Fritts
Buffalo, NY

The Micro Millennium

Dr. Christopher Evans
The Viking Press, 1980
Hardcover, 249 pp., \$10.95

Dr. Evan's book came to my attention a few months ago in a *Playboy* magazine book review. The fact that *Playboy* was reviewing a book about microcomputers set an interest flag in my central processor. A month later I received an advertisement quoting Ray Bradbury as claiming that *Millennium* was one of the most mind-expanding books that he had ever read. That clinched it. I received the book on the day before a rare, short vacation. Other projects planned for the vacation remain incomplete, but I finished the book within the first two days.

The book traces the evolution of computers and their impact on culture up to the present, and projects these trends into the turn of the century. If Dr. Evans' projections are only 50 percent correct, the fireworks have just begun and the most dramatic technological advances and cultural impacts are imminent.

Millennium is divided into roughly five sections: The Past, Present, Short-Term

Future (1980-1982); Mid-Term Future (1983-1990) and Long-Term Future (1991-2000). Evans contends that computers are advancing so dramatically that speculation past the year 2000 is pure recklessness.

The Past is a brief but concise description of the computer's humble beginnings, the major human stars of the story and major technological turning points. Where did IBM come from anyway? Why was the seductive Ada, Countess of Lovelace, fooling around with Babbage's machine? Dr. Evans' sense of humor is a breath of fresh air in computer literature.

The Present sets the stage for the exponential sophistication of computer technology, its impact on our culture and ultimately you and me. The material is aimed at the general reader, digressing to technical details only when absolutely necessary.

The Future sections deal with the likely areas of impact such as the death of the printed word. Why buy an expensive bulky book when you can get it on a ROM chip for 20 cents? Plug the chip into your reader and the reader will tell you the chip's contents or display it conveniently on your bedroom ceiling. At last, a truly worthwhile computer application.

Dr. Evans projects that inroads into the untouchable professions will be substantial by the mid 1980s. He argues that a professional attends school for many

years to accumulate esoteric facts and relationships, then disseminates this information as needed for sometimes exorbitant fees. Surely a computer can find and dispense facts and relationships faster, more accurately, and probably a lot less expensively than a doctor, lawyer or Indian chief.

After all the social upheaval caused by the fundamentalist anticomputer groups, the declining number of hours in the work week and the decline of the work ethic in general, what will we do with our spare time? You guessed it. Turn computer power onto the long-neglected problems of education, medicine, science, man and his relation to the universe.

What kind of computer tools might we expect to have at the turn of the century? Fifteen years ago experts said no computer could be programmed to play a decent game of chess; today there are computers which can beat 99.5 percent of the world's chess players. Soon they will be at the International Master level. How much longer will it be before the chess champion of the world is a computer? Now things really get interesting. If man can design a machine that can consistently out-think him in some area, can he not design an ultra-intelligent machine to design the next generation of UIMs to push the man-machine intelligence gap even further? Most of us that have had

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much contact with computers have briefly considered the can-computers-think question, and answered smugly in the negative. If you read this book you may want to reevaluate your position.

The Micro Millennium is a thought-provoking glimpse into the near future. If the computer revolution catches you unprepared, don't say Dr. Evans didn't warn you.

J. A. Cuchiaro
Encinitas, CA

For Me and You and the 1802

Jeff Duntemann
301 Susquehanna Road
Rochester, NY 14618
Paperback, 30 pp., 1980

Finally, a book about the Cosmac 1802! This often underrated microprocessor has given many hobbyists a start in microcomputing, through the home-built Cosmac Elf and its commercial cousins. *Captain Cosmo's Whizbang* is all about such small 1802 systems, from the author's adventures in building one to plans for expanding the trainer to a full-blown microcomputer system.

The book consists of 30 pages (large pages and small type) of articles assembled in loose order. A comprehensive index, rather than a table of contents, is provided. In these dozens of articles, from a paragraph to more than a page long, is a wealth of information. There are articles on building and modifying an Elf, parts, wire-wrapping, programming, expansion, music, video, mass storage and power supplies, to name a few of the topics covered. There are program listings for sound effects, animation, Morse code, video sketchpad and more, ready to key in. Throughout the book you will be amused by the antics of Cosmo the robot, who advises: "MOS can often be found on the north side of trees!"

As a veteran Elf hacker, I found Duntemann's book highly informative. Articles such as the one describing the VIP bus structure have inspired projects I will eventually implement on my own Elf. A beginner would not feel lost in this sea of information, either, for much of it is oriented toward the kind of novice the author once was, as is shown by the introduction:

"...I'll never forget the incandescent blaze of understanding that roared out of my ears when another computer freak friend finally explained what an instruction set was... EPIPHANY!!!! A COMPUTER IS A BOX WHICH FOLLOWS A PLAN!... With that out of the way, I knew I had to have one."

One of the book's best features—too seldom seen in computer literature—is Duntemann's straightforward, conversational style. His articles do not have to be read over and over just to glean the bare

facts; he presents the most complex subjects in a clear, understandable form.

The only criticism I have is that the programs presented are mostly for systems, like the VIP, with more than 256 bytes of RAM. Perhaps this is just a gripe from someone who has not expanded the original single-page Elf memory yet. Anyway, he does include a simple and inexpensive plan for memory expansion, perhaps with such situations in mind.

Captain Cosmo's Whizbang is a must for anyone who owns an 1802 system. Even Studio II owners can find out how to harness the computer hiding inside their TV game. For those who are just thinking about building or purchasing an 1802 system, the book is a valuable source of information and ideas; the author discusses the Cosmac's flaws as well as its advantages.

Most of you reading this review have never even heard of the book before, as it has not been widely advertised. Word of mouth will provide most of the publicity it gets, so tell all your 1802-hobbyist friends. When you get *Captain Cosmo's Whizbang* you won't be able to wait to try out all of the projects and programs.

Larry Stone
New Haven, CT

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PERSPECTIVES

(from page 242)

business or plant because of the heavy costs of the equipment and staff it required. Often, only the heavier accounting functions have had the heaviest applications, and other functions, such as purchasing, continue as before.

Most of the challenge to reduce clerical work has not yet been met. In any medium-sized business you will see inordinate amounts of clerical work still being done. These are the smaller jobs which everyone does.

A Call to the Industry

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Industry Must Meet His Demands

To an industrial engineer like myself (really an efficiency engineer), whose main purpose is to cut costs for a business or manufacturing plant, the microcomputer is the most exciting, and yet the most frustrating, piece of equipment to come down the road in years.

We industrial engineers must find out where the costs are highest and get whatever is needed to cut those costs, whether it is a new system such as an incentive, or a new piece of equipment such as a microcomputer. As a project engineer also responsible for planning, I need to look up ahead, get ready for the future and make that future happen.

I can see an explosion coming in the use of microcomputers. I wonder how long it will take for equipment manufacturers to get over the last hump to widespread use in medium-sized businesses and manufacturing plants, where there is a crying need to streamline clerical work and increase industrial productivity.

Let's take a quick look at what's good and bad about what is already on the market.

First, the price of equipment is already down there where it needs to be, and that is the hardest hurdle to jump.

Second, the equipment has the memory and program capabilities needed to handle most applications.

Third, BASIC provides a fairly good method of programming. And here is the first qualification—"fairly good." The microcomputer industry has a better language, Pascal, which makes better use of the microcomputer and the programmer, and any edge in efficiency cannot be overlooked by an industrial engineer. Still, BASIC will certainly do for now.

Martin Klaver is Senior Project Engineer for Special Projects and Planning at Lenox China, Inc., Pomona, NJ.

So then, where are the problems?

Is it in marketing, which appears to target the hobby or game interest first? Is that scaring off serious applications. I doubt it.

Despite all the emphasis given to the "game" image, any industrial engineer worth his salt would use any equipment needed to cut costs, no matter what it was promoted for. I have seen roller skate wheels put to work in the design of a machine.

Can it be that industrial engineers are unfamiliar with the possibilities of microcomputers to cut down clerical work? That may be true in part, but you will see industrial engineers using microcomputers to control nearly all small machines in production operations well before desk applications are fully exploited. The machine applications will come before the white-collar applications for the following reasons.

1. The machine hardware is there now, in the proper configuration.
2. EPROM controls are cheaper than conventional controls in many cases.
3. EPROM controls will cut maintenance costs and improve reliability.
4. Microcomputers, using a display, can actually tell the machine operator what to do and when to do it. This enforces operating procedures like never before; unless procedure is followed, the machine does not operate.

In fact, if you look closely at the new machine controls, which come in great variety, they have some of the attributes microcomputers will need if they are to be successfully used for reduction of clerical work.

1. They normally have a numeric keypad, which is absolutely essential in an office machine, too.
2. They can tell the operator what to do through prompting.
3. They can be programmed in one place, using a microcomputer to produce a master program that can be run else-

where by slave units.

Desk machines, intended for clerical work, also need keypads, prompting and master-slave configuration to be effective in reducing clerical work done over and over again, whether it be a short-term application done eight hours a day until that particular job is done or a regular job done a few hours a day every day or every few days. The person doing the clerical job may not be a clerk; indeed, everybody deals with figures.

We industrial engineers need units we can quickly program for specific and specialized applications and hand to someone in a portable package to run that program, with full prompting. We can save everybody's time with such applications, including the time of the most highly paid people in our companies. We can give them the use of mathematics and systems they do not even need to understand in order to solve the problems they need to solve.

So, why not use the equipment already available?

When you start seriously looking, you find that the right combination is not there.

The micros appear to be directed to the macro applications, such as payroll, which in most medium-sized businesses are already handled by central data processing systems. These larger systems may have programming which is obsolete and costly by present-day standards, but they will not be replaced by microcomputers.

The larger data processing systems took the icing off the cake, but most of the cake is still there, in the form of micro applications, the smaller jobs which make up most of the work.

It was never worthwhile for large data processing systems to handle most of the clerical work done in a medium-sized

(continued on page 238)

If you can type, you can handle your accounting, word processing and much more on ISC's Small Business Computer!

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